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SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS

THE MAN-TESTING LABORATORY WHERE EXPENDED ENERGY IS MEASURED.—[See page 187]

Vol. CXXV. No. 11
September 10, 1921

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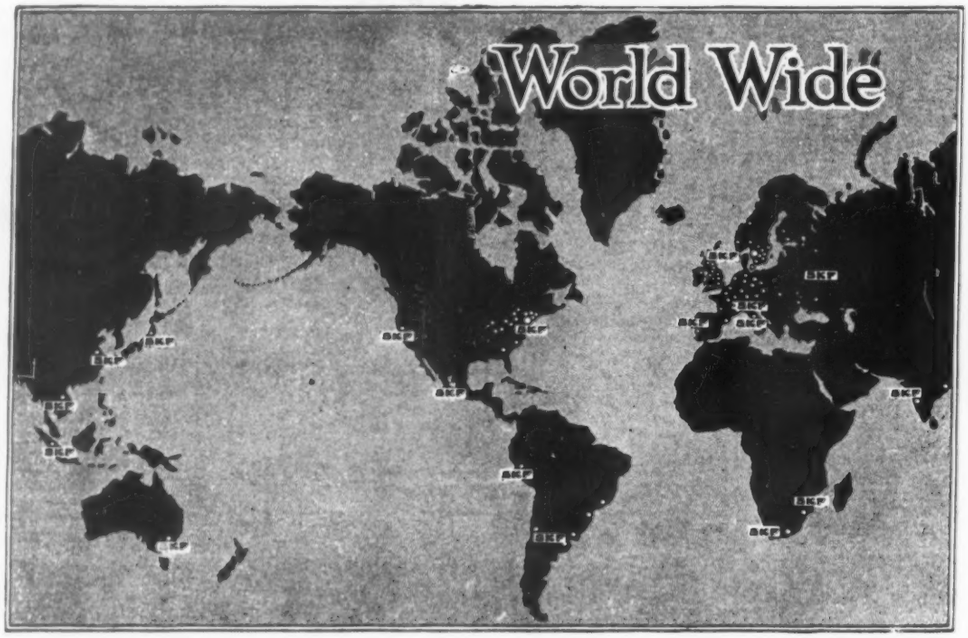

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SEVENTY-SEVENTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXXV. NUMBER 11 | NEW YORK, SEPTEMBER 10, 1921 | 15 CENTS A COPY 20 CENTS IN CANADA

Announcement

The Scientific American publications are to be combined into a single monthly magazine. After seventy-six years of continuous publication the present Scientific American is to be enlarged both in physical size and editorial scope, and converted into a monthly, beginning with the issue dated November, which will be published October 20, 1921. Succeeding issues of the combined publications will be published on the 20th of each month. This change has been determined upon for the following reasons:

In the month of January, 1920, the weekly Scientific American Supplement, after forty-four years of publication, made its appearance as a monthly. The advantages appeared to be so many, the drawbacks so few, that the change was made with full confidence that the Scientific American Monthly would meet with approval. If letters of congratulation and increased circulation are the true test, the change has been an unqualified success.

For many months past the publishers have discussed the advisability of making a similar change in the parent publication, the Scientific American weekly. Here also the practical advantages to be gained greatly outweighed the drawbacks. Reluctance to make the change was due perhaps more to sentimental than to practical considerations. We are free to confess that after bringing out the Scientific American week by week for over three-quarters of a century, we feel a twinge of real regret in making this break in the long continuity. It is done, however, for the very good reasons that, by combining the two present periodicals in a single monthly magazine, we can present the same material in a better balanced, and more complete and fully digested form, and at a far lower cost to the reader.

In the matter of contents and quality we can assure the reader of the present weekly and monthly that the new magazine, which will combine the two publications, will contain within its covers the best features and the distinguishing qualities of each, and will embrace all branches of Science, Research, Engineering and Industrial advance.

An innovation, which we feel will be widely approved, will be that, as far as possible, each article will be completed on the page on which it appears, or on the pages immediately succeeding.

Following the main body of the text, space will be devoted to various departments, and to a complete digest gathered from all of the technical journals, domestic and foreign, and covering the general scientific happenings of the month in a closely condensed and readable form.

Among the longer articles will be found a selection of the best of the learned papers, read before technical societies, such as hitherto have appeared in the Scientific American Monthly, and it is needless to say that our present subscribers to the weekly Scientific American will find in the new journal all those characteristic features which have won for the parent paper such widespread approval.

The new Monthly will be greatly enlarged in number of pages, but will have the same sized page as the present Scientific American weekly.

In these days of heavy taxation and high cost of living, the question of price takes on special importance, and here it is that the change, combining the two periodicals into one magazine, affording opportunities of enormous economies in manufacturing, mailing, and in fact, in all the mechanical labor incident to production, enables us to make a very material reduction in the cost to our readers.

The subscription price will be $4.00 a year, and 35c a copy on the newsstands, as compared with $6.00 a year for the present Scientific American and $7.00 a year for the present Monthly. In the new Monthly, however, we shall give in a single magazine costing $4.00, the technical literature which we formerly published in two separate periodicals.

Subscriptions to either or both the Scientific American weekly and the Scientific American Monthly, which extend beyond October, 1921, will be adjusted and extended to equalize the difference in price.

The present weekly Scientific American and the present Scientific American Monthly are to be combined into a single monthly Scientific American. The first issue of the new combined monthly publication will bear the date of November, 1921, and will appear on October 20th next.

The new monthly Scientific American will retain the distinguishing characteristics of both of the present journals. It will have increased reading matter, more illustrations, and a broader range of subjects and interests.

The subscription price to the new monthly Scientific American will be $4.00 a year. The price per copy will be 35 cents.

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Bending Strength of "ZR-2"

IF "ZR-2" buckled while she was making a sharp turn at high speed—and more than one witness has testified that she did—she was the victim of a lack of girder strength which is inherent in all airships of the rigid type. By this we do not mean to say that all dirigibles are weak to the point of danger, but we do wish to emphasize the fact that the frame of a dirigible is so constructed that it cannot be considered as a trussed beam, and therefore its great diameter or depth cannot, as in the case of a bridge truss, be taken as a measure of its bending strength.

This inherent weakness is due to the fact that the presence of the huge gas bags prevents the introduction of any longitudinal, diagonal ties across each section or panel. To use these it would be necessary to provide gas-tight tubes passing diagonally through the gas bags—an obviously impossible construction. An attempt is made to provide longitudinal strength by bracing and tying together the longitudinal girders and the exterior polygonial frames, so as to secure something of the stiffness of the shell of a tube; but the whole construction, to the eye of an engineer, looks extremely frail when it is applied, as in this case, to a structure that is eighty-five feet in diameter and some 700 feet in length.

There is, of course, an interior truss running along the bottom of the framework—a triangular truss of great strength and stiffness—but it is shallow as compared with the vast skeleton frame along the bottom of which it lies. When the heavy cross-bending strain, induced by setting the rudders hard over when the ship was running at high speed developed, stresses of compression and tension were set up in the frame of the ship, which the relatively small triangular truss below could not do very much to relieve.

In making the above suggestion we do not wish to throw any doubt upon the practicability of lighter-than-air navigation. Faults either of design, material, or handling existed in the ill-fated "ZR-2"; but this does not prove that dirigibles of the great size of this one cannot be built of sufficient strength to stand any of the reasonable mischances of the air. Now that the wreck is being salvaged and the log of the Commander of the ship has been recovered, we shall probably learn in due course just where the break occurred and why. Every new art has its failures and alas, its disasters accompanied by large loss of life; but the art goes forward. We are among those who believe that the day may come when gas bags can be eliminated and the whole body of the ship sheathed with some light alloy so that it can serve as the container. The all-metal dirigible, for reasons of strength and safety, is as desirable as the all-metal airplane.

Marine Insurance as an Aid to American Shipping

EVERY possible legitimate assistance should be given to President Harding and the Chairman of the Shipping Board in the great task of salvage of the Government fleet of merchantmen which was built under exceptionally unfavorable conditions during the war. Whatever legislation is enacted with this end in view, we should be careful, while rendering every legitimate assistance to our merchant marine, to avoid legislation which can be construed as actively hostile to the proper aspirations and efforts of other nations, and that would give them any just cause for resentment. It is possible to avoid this antagonism and promote the interests of our merchant marine without stirring up bad feelings among the maritime nations which will be our active competitors, when the flow of traffic sets in again with full force.

It is not yet fully understood how vitally important to the successful growth of our foreign commerce and shipping is a proper development of marine insurance in the United States. Both the United States Shipping Board and the House Committee on Marine Insurance state that marine insurance is used as a competitive weapon in international trade, and that it has indeed been so used by other countries in promoting certain leading lines of trade. They state further that under existing conditions, marine insurance companies, because of marine insurance that is placed with them, acquire and utilize vital trade secrets which are exceedingly useful to the nations these companies represent. Obviously, it is important that marine insurance should be taken out by American companies through American insurance firms.

Furthermore, companies dealing in marine insurance business in the United States are at a disadvantage in competing with foreign companies because of governmental (State) regulations and restrictions and excessive taxation. All United States marine insurance companies in addition to heavy state taxes are subject to a further Federal tax of one per cent on their premium income, except on exports; and in addition to this, marine insurance companies are subject to the same taxes as other corporations in the way of income and excess profit taxes and capital stock taxes.

As compared with this heavy handicap, marine insurance on American property placed with companies outside the United States is subject to a stamp tax of 3 per cent on a gross premium, except on exports. Outside of this 3 per cent, marine insurance companies in England and other foreign countries are not required to pay a tax on premiums but are subject to such taxation as is imposed on ordinary business. The Insurance Committee of the Merchants' Association in this city favor the following changes in the insurance laws of the State as recommended by the House Committee on Merchant Marine and Fisheries: That taxation of premiums be abolished and a tax on net profits substituted; that permission shall be granted to marine insurance companies to engage in all classes of insurance excepting Life and Surety; that unnecessary restrictions upon re-insurance with companies of other states be removed; that marine insurance companies be allowed to take credit in their financial statements for foreign deposits and premiums; and lastly, that there should be a recognition of the necessities of marine insurance by special legislation.

A bill intended as a model for use in the various states has been introduced in Congress. It incorporates the features we mention above, with the added proviso of a tax of 2½ per cent on the gross premiums of any marine insurance placed on American-owned property outside the United States through a marine insurance broker. This tax would be additional to the 3 per cent stamp tax which we have mentioned above.

A Detail of Patent Office Examination

PERIODICALLY we read of the over-worked examiners in our Patent Office. Periodically we are informed that this is the reason for the unfortunate delay in the issue of letters patent for inventions. This unsatisfactory condition, however, is not peculiar to Washington; in the patent offices of most foreign countries applications lie dormant for considerable periods owing to the inability of the examining staff to cope with the demands upon its time.

Holland, one of the most recent countries to enact patent laws, and therefore unhampered by the traditions which necessarily cluster about a business that has been going on without material change for a century or more, has recently amended her patent laws in a way that enables the Dutch examiners to avoid a great deal of duplication of work that has been already done elsewhere. It is provided that, where application for a Dutch patent follows or is coincident with the prosecution of applications in countries foreign to Holland, the Dutch examiner may review the art cited by the Patent Offices of other countries. With the authorization of the applicant, the Dutch Patent Office will obtain from its contemporaries abroad such information from the file wrappers relating to the same invention as may be useful in providing the groundwork on which the Dutch examiners may continue their searches. This will make unnecessary many duplicate searches, and will relieve the Dutch examiners of a great volume of work.

With the work of our own Patent Office so seriously in arrears, it might be well to consider a similar change of procedure here. Where the applicant for a patent has filed applications in other countries, if our Patent Office were authorized by him to obtain information concerning all the references which were cited by the foreign Patent Offices during the course of the examination of applications on the same invention, our examiners would have before them a fairly complete history of the art, which could then be augmented to any extent necessary by further and independent search.

The American examiners of course would have to be free, both legally and in their own minds, to draw their own conclusions as to the patentability of the subject matter of an application that had been treated in this way. But we hope that the caliber of our patent examiners is sufficiently high to enable us to trust them in the presence of another man's work, without the fear that they will permit that work to influence them unduly. It seems absurd for each Patent Office to go on making its searches independently, duplicating a great amount of exhaustive work that has been done elsewhere: just as absurd as though we were to sit down with the intent of writing a history of Rome to rival Gibbon's monumental work, and were to refuse to avail ourselves of the list of sources which Gibbon gives us, preferring to tour the museums and libraries of Europe and examine all the ancient documents there to be found, in search of our own sources. It is not a question of allowing Gibbon's treatment of his sources to influence us; the exact parallel is as we have put it—refusing to use his sources until we have discovered them independently. Anyone will agree that this would be irrational; it is in no degree more so than the Patent Office procedure of today, which refuses to recognize the existence of digests of the art not made on the premises.

Technical English

EVERY now and again we find, in our technical and scientific journals a plea for greater attention to correct diction. We are not over optimistic as to the result. Perhaps more can be accomplished by pointing out two or three of the most common errors. The use of "data" as a singular noun has become too common. Is it really necessary to remind technical writers that *data* is the plural of *datum?* It is true that the English language permits the occasional use of a singular verb when the subject is a plural noun denoting a collection of things. But this construction is exceptional. Who would think of saying: "In view of *this facts?*" Yet there is no more warrant for saying: "In view of *this data.*" No: we strongly suspect that those who adopt the faulty construction are blindly and uncritically following a lead that has become all too general. Let us make an effort to break this lead. A good beginning would be made if Government publications would set the example. Our various departments at Washington would seriously resent any charge that they were spreading scientifically unsound information. Why should they not be equally jealous of the correctness of the English diction to which they lend their endorsement?

Another extremely common phrase, which is, to say the least, inelegant, is the use of the word "due" as a conjunction. We quote from a standard work: "By 1809, *due* to the fact that the turnpike system had been extended, there were over one thousand turnpike trusts to keep the roads in repair." The word "due" is etymologically a participle of adjectival function; the correct conjunction to use in such cases is "owing to."

As for the confusion of the verbs "shall" and "will" this, in common business correspondence, has become so prevalent that it seems rather hopeless to attempt to restore order. And yet the rule is so simple: In the first person use "shall," thus "I shall, we shall"; in all other cases use will. You will then be expressing merely futurity of the event. The word "shall" used with the second or third person expresses not mere futurity but some form of constraint, compulsion, or obligation. Similarly the word "will" used otherwise than as indicated above, expresses not mere futurity but an act of the will.

Let us, in print at least, put on our best literary garments.

Electricity

Pliers with Renewal Jaws.—The cutting jaws of the electrician's pliers are nicked and dulled long before the rest of the tool is rendered useless, hence there has always been a demand for some form of renewable jaws. This is realized in a recent tool introduced on the market. The new tool is a plier made in two parts, so that when the jaw is broken or worn out it can be removed and a new one inserted. The manufacturer states that the jaws of the new pliers are made of crucible steel and the handle or body is made of forged steel.

Italian Railway Electrification.—Work on the general electrification of Italian railways is proceeding actively. At the end of August of last year, ten roads, comprising a total of 797 kilometers, had been electrified. From September 1, 1920, to June 30, 1921, five additional roads, comprising 234 kilometers of road, were electrified. During the current year 434 kilometers of road will be electrified. The saving in coal resulting from these electrifications amounted at the end of June to 160,000 tons. By July 1, 1922, it is calculated, the saving in coal will reach 1000 tons a day, causing a daily saving of 200,000 lire, or 70,000,000 lire annually.

Safe Industrial Lighting.—In general, according to the *Transactions* of the Illuminating Engineering Society, bad lighting is caused by one or both of two outstanding factors—(1) bare incandescent lamps, or unshielded glaring illuminants that not only do not illuminate but cause a contraction of the pupillary opening of the eye and resultant decrease in seeing ability; (2) insufficient light, which is largely due to improper lamp renewals, wrong methods of reflector and lamp cleaning, color of surroundings, or lack of efficiency in maintaining the original installation up to its initial standard. The latter factor particularly is discussed in this article.

How a Speaker Could Address Our Entire Population.—A record in projecting speech has been established by the American Telephone & Telegraph Company at an experimental station in the Catskill Mountains, according to *Electrical World*, where a speaker's voice was made intelligible 3.8 miles away through the medium of a loud-speaking telephone. The equipment is similar in some respects to that used at recent outdoor addresses to large audiences but has considerably greater amplifying power. It consists chiefly of electrostatic transmitters setting on the pedestal on the speaker's platform, vacuum tube amplifiers in cascade, and the loud-speaking projectors mounted over the speaker's stand. A single projector established the record, the energy amplification being 10^{10}.

Peter Cooper Hewitt.—It is with deep regret that we must note the passing away of Peter Cooper Hewitt, the American inventor who contributed so generously to electrical progress. Mr. Hewitt underwent an operation recently for abdominal trouble, and death resulted from an attack of pneumonia. Peter Cooper Hewitt was born in New York on March 5, 1861. He was the son of Abram S. Hewitt, one time Representative in Congress and Mayor of New York, and grandson of Peter Cooper, the philanthropist. He was educated at Stevens Institute of Technology, Hoboken, and at Columbia University, graduating as mechanical and electrical engineer. Mr. Hewitt is best known for his mercury vapor lamp, which is widely used for many purposes, notably photographic illumination; his mercury vapor rectifier for converting alternating current into direct; and certain improvements in telephony and radio communication. Of late years he was engaged in developing a helicopter.

Wireless Control of Locomotives.—According to the *Revue Generale des Chemin de Fer*, a series of tests on electrical intercommunication between two electric locomotives driving the same train is now in progress between Paris and Juvisy. The system, which was patented in 1917 by the Orleans Railway Company, consists of an arrangement whereby the locomotive at the head of the train produces a periodical secondary current of low voltage and relatively high frequency. This current is superimposed on the power current and is transmitted by the ordinary circuits which supply the two locomotives. In the locomotive at the end of the train selective receivers are installed which allow different effects to be obtained according to the form of the current transmitted. These secondary currents are used principally for operating the contactor and braking equipment and, of course, avoid the use of a driver at the tail of the train. The arrangement is, obviously more useful on mountain sections where locomotives are used at both ends of the train than for motor trains operated by an ordinary multiple-control system.

Astronomy

The Pons-Winnecke Radiant it appears will supply the earth with no further meteors in addition to those of June, 1916. Professor Barnard and other observers watched all night on June 24th, 25th, 26th and 27th, without results. This makes it appear that the denser part of the meteor swarm did not intersect the orbit of the earth at all.

Proper Motion Statistics.—Kapteyn and Van Rhijn, in the latest of the Groningen publications, No. 30, discuss among other things the total number of stars known with proper motion in excess of two-tenths second of arc, and of magnitudes between 6 and 14. It appears that there are 10,193 such stars known of which 169 are of the brightest magnitude considered—the sixth—while 76 have motion of two seconds or more. The table given shows a complete classification of these stars by magnitudes and by amount of motion, the latter being divided on each tenth-second from 0.2 to 1.0, and then at 1.5 and 2.0 seconds.

Thickness of Saturn's Rings.—In connection with the passage of the earth through the plane of Saturn's rings last November, Prof. W. H. Pickering's observations in Jamaica led him to conclude that while the thickness of the outer edge of the outer ring *A* can be only a few miles, that of the inner edge of the inner ring *B* is some 40 miles greater, while the thickness of the crape ring is about 1000 miles. The latter he believes to consist either of innumerable small distinct clouds of ice crystals, like our cirrus, or possibly of a uniform cloudy structure of extreme rarity, the temperature of the minute drops of water being maintained by their proximity to the hot planet.

Interference Methods in Astronomy.—In *Nature* for July 28th appears a comprehensive article by H. Spencer Jones, Chief Assistant at the Greenwich Observatory, upon this subject. While hardly more complete from a popular viewpoint than Dr. Russell's articles in our own columns, it gives considerably more material of exclusive interest to the astronomer. The layman's chief reaction to this article will be amazement at the assurance with which such magnitudes as 0.0458 and 0.0451 *second of arc* are discriminated. Modern precision measurements are decidedly more startling when applied to the minute evaluation of angles than to ordinary linear dimensions.

A Double Service of Astronomical Telegrams.—The action of the interallied International Astronomical Union in establishing a new bureau for the exchange of astronomical telegrams at Uccle, Belgium, intended to supplant the long-established institution at Kiel, has had the result that might have been expected. In the early days of the war the work of the Kiel bureau was, very properly, transferred to a neutral establishment, viz., the Observatory of Copenhagen. The Allied countries, however, established a provisional bureau at the Observatory of Paris, which transferred the work to Uccle in 1919. Meanwhile the Observatory of Copenhagen, under Professor Strömgren, continues to act as the distributing point for astronomical telegrams from the Central Powers and certain observatories in other countries. Fortunately an agreement has now been reached between the bureaus at Uccle and Copenhagen so that each receives and distributes to its subscribers the telegrams received from the other.

Observing Sunspots Without a Telescope.—Every astronomer is familiar with the controversies that have arisen concerning the true character of minute planetary markings, especially those observed on Mars. In order to determine how much dependence should be placed upon the human eye in this connection, Mr. E. Walter Maunder, in England, organized about two years ago a corps of volunteer observers who undertook to make a systematic daily examination of the sun for the detection of sunspots without telescopic power (*i.e.*, using only a dark glass). His idea was that a comparison of these observations with simultaneous telescopic observations and photographs would serve to throw light upon the limits of naked-eye vision. A preliminary report on this undertaking states that of 259 days of observation 96 showed spots visible to all who were observing on those days. On 23 days discordances were noted between observers. A sunspot with area less than 700 millionths of the sun's disk at mean distance appears to be too small to be detected by average good sight. On the other hand, the observers seldom failed to secure a definite observation of any spot that covered 900 millionths or more. To express the same thing in another way, a well-defined circular dark spot on a bright background should have a diameter of 31 seconds of arc to be visible to the naked eye, while one having a diameter of 36 seconds ought not to escape a careful search made under good conditions.

Industrial Efficiency

Osmiridium Deposits.—Recent exploration and development have revealed enormous deposits of osmiridium and gold-bearing gravels in the valleys of the large rivers of the western division of Tasmania, which is the sole producer on a large scale of point metal osmiridium. Tasmania, Russia, Colombia, and Papua are the four principal osmiridium producing countries of the world, and Tasmania is by far the most important of these.

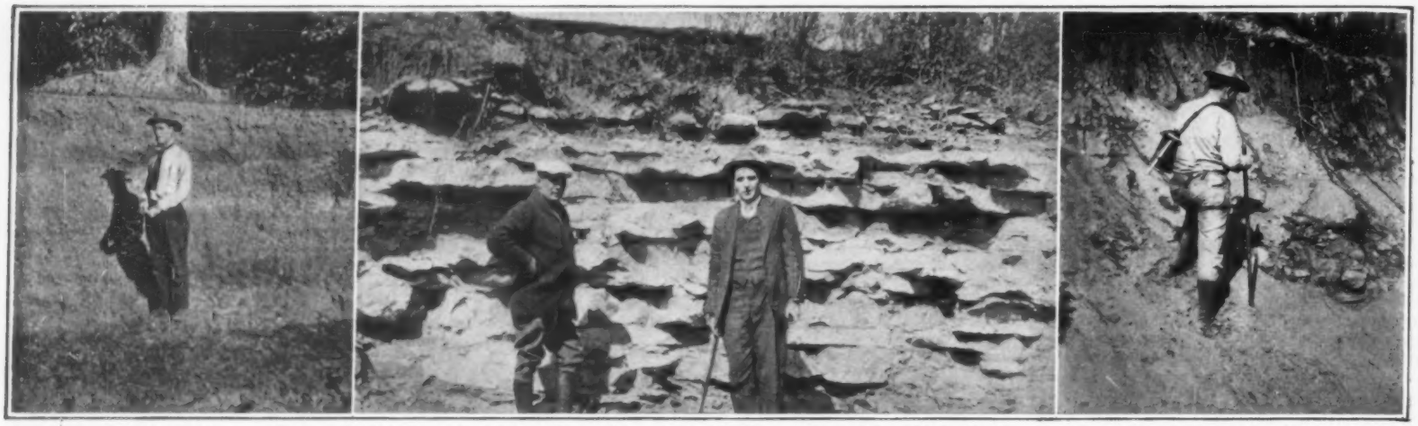
The Total Value of Our Foreign Trade in merchandise dropped from $13,347,000,000 in the fiscal year 1920 to $10,171,000,000 in 1921, a decrease of $3,176,000,000, or at the rate of 23.8 per cent. This loss was nearly equally divided between imports and exports. Imports dropped from $5,238,000,000 in 1920 to $3,654,000,000 in 1921, a loss of 30.2 per cent; while exports, amounting to $8,109,000,000 in 1920 against $6,516,000,000 in 1921, decreased $1,593,000,000 in value, but only at the rate of 19.6 per cent.

The Handbook of Northern Wood Industry, or to give it the original title, *Hndbook för Nordisk Träindustri*, which is well known in all circles connected with the wood industry and covers all information in regard to timber, wood pulp, and paper industries in Sweden, Finland and Norway, has just appeared in a new 1921 edition. The preceding edition was published in 1913, and changes and extensions in the Northern timber industries have taken place, especially during the war, so that it became necessary to publish a revised edition. The handbook contains detailed information concerning industrial combinations and export organizations in the different countries in the sphere of the wood, wood pulp, and paper industries, with complete lists of the members of the boards and associations.

Again the Question of Packing.—Many wood packing cases arrive at their destination broken, with the contents damaged, because the man who nailed the box or crate together failed to put in the right number of nails. A good rule is to space the nails not more than two inches apart, states an authority writing in *The Times Trade Supplement*, except when nailing up crates or boxes whose sides and so on consist of more than one piece. In such cases the narrow pieces must never have less than two nails in each nailing end, and if more than 2 inches wide, the number of nails must be proportionately increased. Bales should not be bound with rope. American firms have lost many good orders through "tying their parcels with a bit of old string." The best ties are painted iron or steel strips about 1¼ inches wide at least and 7 to 8 inches apart.

The Division of Commercial Laws, a newly created division of the Bureau of Foreign and Domestic Commerce, is prepared to receive inquiries from American business men and lawyers relating to commercial laws of foreign countries, the taxation of American firms doing business abroad, formalities in connection with bankruptcy proceedings in foreign countries, powers of attorney, etc. The Division will eventually have a complete library of civil and commercial codes of foreign countries as well as of representative foreign law publications. In cooperation with the consular officers, commercial attachés and trade commissioners a file of reputable law practitioners in the important commercial centers will be prepared for the convenience of American business men and their council, but without any obligation or responsibility being assumed by the Division in this connection. The scope of the operations of the new Division is rather large and it has been designed to meet the long-felt need for an information center on foreign commercial laws.

The Unemployment Situation varies from one country to the next. Thus in the United States the unemployment situation appears to be getting worse rather than better, while in France it is getting decidedly better. Our own country is faced with the none too pleasant thought of having perhaps as many as five million unemployed—New York City alone expects half a million unemployed during the winter, although a goodly proportion of this number is the influx from other parts of the country. In France, on the other hand, the unemployed totaled in the neighborhood of 100,000 up till a short while ago, and at this writing the number has receded to about 70,000. There are no definite statistics on this subject, but the French Government reports that the number of unemployed assisted by the Government reached 47,124 in January, 1921, and increased to 84,810 on April 30th; but on June 24th it had receded to 54,002. The German unemployment situation is reported to be improving rapidly. The British situation is still dark and uncertain.



Left: The geologist has located a readily accessible bed of gravel, of fine wearing surface. *Center:* Deciding on the most favorable location for a road foundation. *Right:* Consideration of the road-building materials near the site has as much to do with placing a road as has the character of the actual roadsite

Where the geologist lends his aid to the difficult task of locating the road

The Geologist's Part in Road Building

How Wisconsin's Highways Are Located with Expert Scientific Advice

By George H. Dacy

PROFITING by the mistakes of other states that have markedly increased road building expenses by not efficiently surveying the sections which the roads penetrated previous to construction in order to locate all available material, the Wisconsin State Highway Commission is making unique utilization of the trained geological experts on the Badger payrolls. These geological experts make complete surveys of the road building material resources of the belt through which each new road—be it gravel, macadam or concrete—passes before the initial road improvement activities are started in order to appraise accurately the debits and credits in rock and gravel materials available locally. In each instance, this survey is extended backward from either side of the road a distance equal to the wagon haul from the nearest railroad town.

One of the most critical expenses in building improved highways under existent conditions is the cost of transporting road metal from distant supply points and, subsequently, of freighting it by wagon or motor truck to the rural construction location. By her efficient use of scientific and geological skill, Wisconsin is eliminating this avoidable expense—in many instances—from her highway construction bills, while, in other cases, she is reducing it to a minimum by the economical, supplementary use of imported materials as reenforcements for her local resources. In dollars and cents, this saving foots up to big amounts as is illustrated by the fact that last year according to the advance geological survey practiced in Badgerdom, adequate amounts of local sand and gravel were secured at an average cost of $1.46 a cubic yard whereas the same materials from commercial pits would have cost an average of $2.85 a cubic yard.

Assuming the average railroad haul at 5.5 miles, the use of local material of this description results in an additional saving of $1.11 a cubic yard for transportation costs. This figures up to a gross saving of over $3600 a mile of concrete road. Furthermore, an economy in truck and wagon haul aggregating from $1650 to $3300 a mile often obtains per mile of highway constructed. As a rule, the customary hauling charge is 50 cents a ton for the first mile of wagon or truck haul and 25 cents a ton for each additional mile. Improved highways usually are built out from central railroad towns to which the materials are shipped by rail and then hauled over the road. When the construction work reaches a point 8 to 10 miles from the railroad, the freighting charges attain exorbitant dimensions.

It is worthy of mention that Wisconsin's state highways which now cover 7500 miles and are maintained in excellent condition by 911 patrolmen who individually maintain stretches of roadway averaging over 8 miles a man constitute one of the best chains of improved pathways east of the Rocky Mountains. The geological surveys in addition to being fruitful for the original location of local material for constructing the roads are also of inestimable importance in providing material for the repair and proper maintenance of the highways. The all-round efficiency of a roadway is measured in terms of its maintenance. Wisconsin roads are among the best because proper surveys have been instituted to render available maintenance material for present and potential needs. Last year Wisconsin expended $2,125,000 in maintaining 7500 miles of highway. It cost $1.87 a mile to keep the earth roads of the state in repair; $1.84 a mile for the gravel roads; $540 a mile for macadam and $220 a mile for concrete roads. Just compare these expenses with those of any other state which does not follow the geological survey system and you will immediately appreciate how important is this reconnaissance work as measured in annual upkeep costs.

During the current motoring season Wisconsin is featuring another innovation in the way of special, road-condition, report service. It takes the form of a blue print map of the state appropriately showing all the trunklines and important highways and their condition. This map is issued Wednesday of each week and is distributed to nine branch stations of the State Highway Department in leading cities as well as among the most important hotels. The map is 54 by 60 inches in size and must be displayed on a special bulletin board placed in a conspicuous position in the lobby so that the general public may avail themselves of the information it supplies. The map is issued the middle of the week so that all tourists and motorists planning week-end trips may have most recent road information at their service. The map describes the kind—earth, gravel, macadam or concrete—of road and its condition, whether it is under repair, the condition and character of the detours and other facts of interest to automobilists. Supplementary weather report service is furnished by the U. S. Weather Bureau from Madison, Wisconsin, daily to all the parties that receive the maps so that the motorist may also benefit by these reports about the potential antics of old Sol and Jupiter Pluvius.

The geological surveys in many cases have resulted in a complete change in the type of proposed road construction followed. For example, in one neighborhood the intention was to build a temporary gravel road. The survey showed that the supplies of local gravel were very limited and that a concrete road would be the most efficient and satisfactory highway to build in that section. In some of the sandy sections of the state, clay proves to be the best material to use for surfacing above the sand. Search is ordinarily made for shale in the sandy sections as this material is ideally adapted for highway use. In some of the counties where granite prevails in large quantities the purpose of the survey is to locate accumulations of disintegrated granite as this material makes a very satisfactory and durable road. The granite wears well and sheds water admirably. Briefly, the intensive studies and observations of the Wisconsin geologists is resulting in the standardization of the highways in accordance with the character and type of the local road material supplies. Wisconsin has realized such success as a consequence of using her state geologists as prize aids in her road building campaign that recently Pennsylvania, Maryland, Illinois, Missouri, Minnesota and Iowa have copied her methods and now are decreasing their highway construction expenses in a similar manner.

Dicyanin

SOME years ago, Dr. Kilner, late electrician at St. Thomas' Hospital, London, whose book on the human aura is well known, said that the discovery of a screen to make the aura visible was not accidental. He had been reading about the action of the N-rays upon phosphorescent sulfide of calcium and had experimented upon mechanical forces of certain bodily emanations.

Early in 1908 he thought certain dyes might help him, and fixed on the coal-tar dye dicyanin.

When the dye was obtained glass screens were made, the only satisfactory ones being glass cells filled with an alcoholic solution of dicyanin.

It was recognized very early that constantly looking through the dicyanin screens had an influence on the eyesight, an influence which is not altogether understood today. Everyone who uses the screens finds the eyesight markedly improved. Most were slightly presbyopic.

Modern commercial photographic plates were found comparatively insensitive beyond λ50, but experiments at the Bureau of Standards, Washington, D. C., convinced the experimenters that with dicyanin it would be possible to get the specter of bright stars as far as λ80.

But the dye deteriorated quickly and there was ignorance of the spectral region in which dicyanin was most valuable. Dicyanin could not be depended on to preserve its useful properties indefinitely under ordinary conditions. Some change took place which destroyed its sensitizing value.

The fact that dicyanin does not sensitize the plates to green and yellow is apparent from the photographed spectra. The blue and red portions of the spectra are usually separated by a gap representing the insensitive organ. The addition of pinaverdol to the staining bath is an improvement.

Staining Solution	cc.
Distil. water	140
Ethyl alcohol	120
Dicyanin A (1:2000)	18
or Dicyanin 1:1000	7
Ammonia, 26 degrees	9

The human aura consists of a number of layer or strata one beyond the other extending out into space. There is the "etheric double," which entirely surrounds the body, conforming to its shape. Beyond this is the inner aura, 2 or 3 inches broad, and, beyond this again, the outer aura extending 5 or 6 inches, the outer part of which is termed the ultra-outer double.

Dr. Kilmer thinks the force from which the aura arises is generated within the body itself. He tells of details concerning the effect of electricity and chemicals on the inner aura, and the changes in shape and size of the aura generally as the result of nervous disease.

Developing Motion Picture Film with Automatic Machinery

By Harry A. Mount

IT will be a surprise to many persons to learn that in this day of labor-saving machinery most of the millions of feet of motion picture film in use is developed by hand. This is because the machines hitherto devised for the purpose of developing film have been cumbersome and expensive and not fast enough to make their installation profitable except in one or two of the largest film laboratories.

A new film developing machine recently placed on the market apparently overcomes these difficulties. Although it occupies a floor space only eight feet long by two and a half feet wide, and is four feet eight inches high, it develops a thousand feet of film an hour, delivering the film dried, ready for the projector. Another model, double this length but with other dimensions the same, will have a capacity of four thousand feet an hour.

The machine is almost entirely automatic in its action, requiring the services of only one operator who has simply to watch for over- or under-exposed film and to slow down or speed up the passage of the film through the developing tank accordingly.

The tank is constructed of boiler iron heavily nickeled inside and out. It is divided into six compartments, one each for developer, wash, fixing bath, wash, final wash, and drying. The first four of these are arranged on one side of the machine and the other two are placed on the opposite side, with a water jacketed partition between. The heat of the water in this jacket controls the temperature of the developing and fixing baths. The film passes with a helical motion up and down through the solution and finally into the next compartment. Offsets in the partitions allow this passage from one compartment to the next without a twist in the film. The air for the drying compartment is forced in at the bottom by a blower, passing over electric heater coils which slightly warm it. The film is uniformly dried, regardless of weather conditions. There is an air brush attachment for tinting the film during the development process.

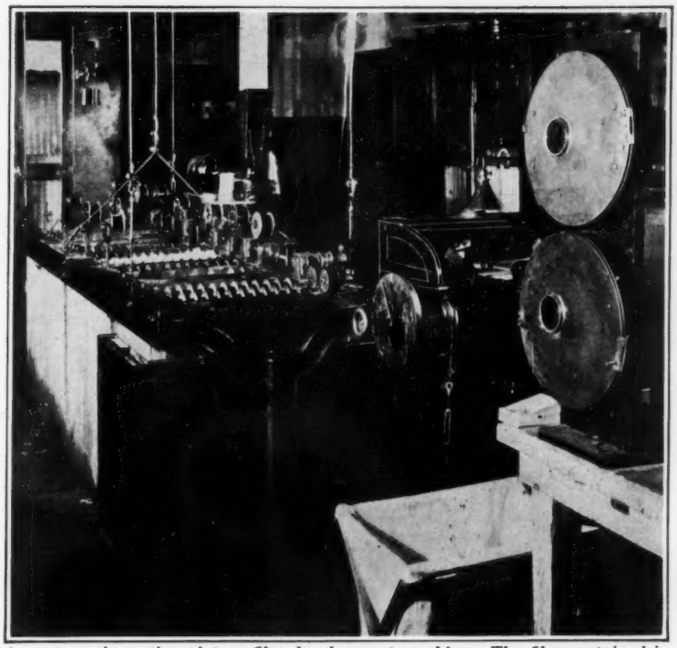
The whole mechanism can be lifted clear of the tank by a compressed air cylinder, so that breaks can be mended and adjustments made quickly. While in this position the action of the developer is delayed by a water spray which plays on a portion of the film. An automatic device stops the machine if a break occurs, but this is a rare occurrence. In fact, over fifteen thousand feet have been developed on the machine pictured without a break in the film or any other trouble.

A combined flushing and siphon system makes it easy to clean the machine, only fifteen minutes a day being required. The machine is operated under a ruby light, and five small lights behind the film allow the operator to examine it during development.

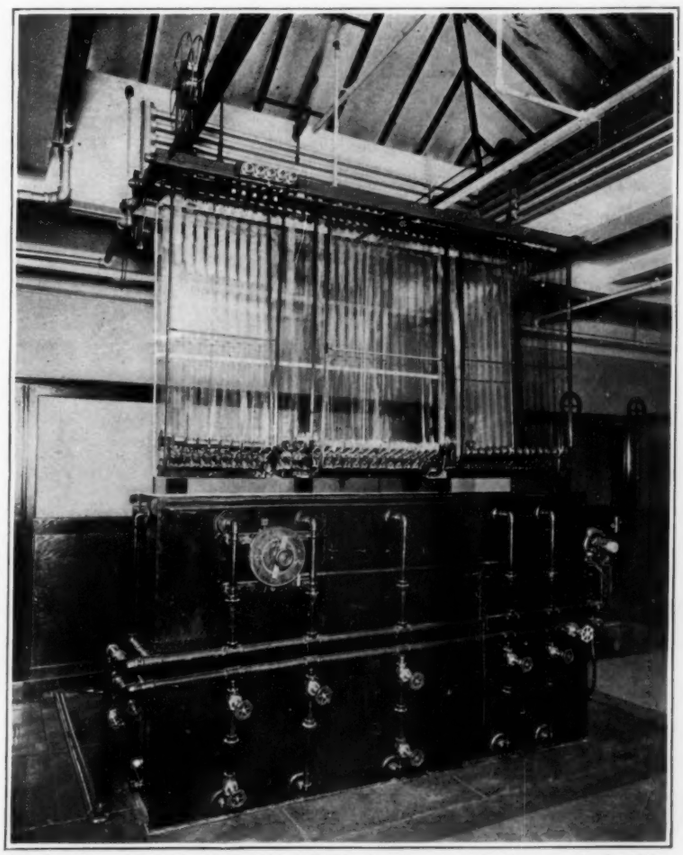
The usefulness of such a machine to large motion picture concerns may be judged from the fact that the small machine pictured below takes the place of a whole film developing laboratory occupying 1500 square feet or more of floor space and employing a number of men.

Another film developing machine, which, in its general principles, resembles the machine already described, has recently made its appearance. It is said to eliminate all the undesirable, expensive, wasteful and inadequate laboratory methods; much cutting and splicing, reducing splices in each one thousand feet from forty or more to not more than two splices in each one thousand-foot reel; excessive use of expensive and rare chemicals; seventy per cent of the laboratory help; all loss from careless or inferior development; all loss from accident to film; all loss from dirt, dust or marks on the film; all loss from scenes or parts mislaid or lost; all loss from over-printing of sectional parts.

This machine, which is shown in the upper illustration, is intended for positive film, which has a slower emulsion than the negative stock and can be developed in much brighter light. Furthermore, the positive stock has a greater latitude of development, which allows for the handling of many different scenes, with different exposure values, in one strip. It is a question whether the usual run of negative, with over-exposed and under-exposed sections, could be so handled.



An automatic motion-picture film development machine. The film contained in the magazines is passed to the rollers and tanks at the left



Another type of automatic motion-picture development machine, with the film-handling mechanism raised to remove the film from the tanks

Water Level and Weather Observation Station at the Salton Sea

By John Edwin Hogg

IN all the years that the Salton Sea has been the object of human interest because of its constantly varying water levels, temperatures, and degrees of salinity, no accurate scientific data concerning it exists. Similarly there is no accurate data concerning the weather conditions existing about this great inland sea which is the only body of water in the western hemisphere with its surface below ocean level, and the lowest body of water on earth with the exception of the Dead Sea of Palestine.

In 1904 it is known that the Salton Sea was 266 feet below sea level, and in 1905 its surface level changed to 246 feet below sea level when the Colorado River overflowed and flooded its great below sea level basin. Since the flood of 1905 the surface of the Salton Sea has constantly raised and lowered, depending upon the rapidity of evaporation, which is the only means by which the sea's level is lowered, and the amount of water flowing into it from surplus irrigation water from the Imperial and Coachella Valleys and the several fresh water streams flowing into it.

Since a valuable fishing industry has come into existence on the Salton Sea, and billions of dollars worth of irrigated lands are dependent upon the conditions existing there, the Government has realized that accurate water level, water analysis, and weather data, are of great importance; and an observation station was recently (May, 1921) established on Mullet Island, a small volcanic plug that protrudes above the surface near the Imperial County (California) shore. The observation station has been placed by the United States Weather Bureau at Washington, in charge of Captain Charles E. Davis, the originator of the fishing industry, who lives on Mullet Island. Henceforth daily reports are to be kept, and placed on file at Washington concerning the Salton Sea.

The Salton Sea observation station is located at a lower negative elevation than any other institution heretofore established. The observation station at Furnace Creek on the floor of Death Valley formerly held that distinction, it being 187 feet below sea level. The Furnace Creek station, however, is eclipsed by the Salton Sea station with its elevation of 257 feet. It may be said that the Furnace Creek station is not located at the lowest point in Death Valley. The greatest depression in Death Valley is the Frying Pan Salt Marsh, which is 280 feet below sea level. The Salton Sea is 68 feet deep at the deepest point yet sounded, so that if it ever dries up completely as has often been predicted, a depression 325 feet below sea level would be left. This would create a depression 45 feet lower than the lowest point in Death Valley, which is now the lowest point of dry land on the western hemisphere, and the lowest on earth with the exception of the valley of the Dead Sea which is 1300 feet below sea level. Thus should the Salton Sea evaporate it would supplant Death Valley as the second deepest depression on the surface of our planet.

Should the Salton Sea ever raise its surface to ocean level as it threatened to do when the Colorado River overflowed into it in 1905, portions of three enormous California counties which are all below sea level would be inundated. This below sea level area embraces the entire Imperial and Coachella Valleys, whose irrigated farms are among the most productive on earth, valued at billions of dollars, dotted with numerous prosperous cities, and producing millions of dollars annually in the value of crops alone. On the other hand, should the Salton Sea ever recede to the point of increasing its salinity beyond the endurance of fish life, the valuable fishing industry in operation there would be automatically eliminated.

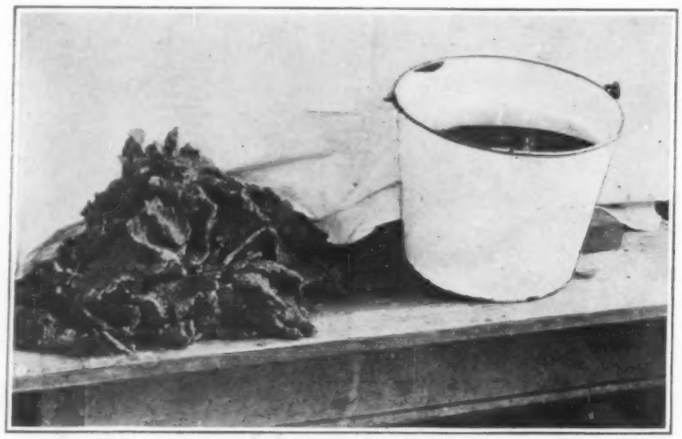
The All-Around Vegetable

The Many Uses of the Sweet Potato, and How to Make the Most of Them

By S. R. Winters

THE 1921 sweet potato crop for the entire United States—accepting the July forecast of the Bureau of Crop Estimates—is sufficient to produce approximately 200,000,000 gallons of syrup—a volume suggesting a revision of the Biblical phrase, "a land flowing in milk and honey," to that of a soil drenched in sweet potato syrup. The figure of speech is particularly applicable to the South, where nearly 90 per cent of the "juicy yams" are grown. Alabama, Georgia, North Carolina, Mississippi, Texas, and Louisiana—in the order named, are the principal sweet potato producing states—each harvest from 8,000,000 to 18,000,000 bushels annually.

Of course, the supposition that 112,023,000 bushels of potatoes will be converted into syrup is but a fantasy—a flight of imagination! The sweet potato lends itself to a variety of uses—in fact, an instructor in a negro college in Alabama recently testified before a Congressional committee that this southern vegetable food was being used in 100 ways. Without attaching credence or disputing this claim, there is no gainsaying of the flexibility of this underground root crop whose spreading vines literally dot the Southland. And, sweet potato syrup is the latest addition to its constantly expanding uses. A process developed by H. C. Gore, chemist-in-charge, fruit and vegetable utilization laboratory of Bureau of Chemistry, United States Department of Agriculture, makes possible the manufacture of sweet potato syrup both in the home and factory. A production unit, recently established by the Government at Fitzgerald, Ga., will determine the feasibility of the commercial application of the process. The initial experimental run of the factory machinery yielded 600 gallons of syrup and the costs of producing and marketing the product are being studied. Meanwhile, Southern homes can apply the process to effect in extracting table syrup from the humble tuber.



The syrup and the dried pomace from a bushel of sweets

The recipe for preparing the liquid sweetening on farms has been successfully established by laboratory experiments. The original formula, however, as announced a few months ago, has been modified by subsequent determinations of the Bureau of Chemistry. The modification of the method of preparation is in the interest of a well-flavored product. The use of malt made from barley or wheat is somewhat restricted by the amended process inasmuch as the sweet potato has disclosed certain contents which enable it to digest its own starch. Yet, a limited quantity of malt can be employed to advantage. The potatoes are boiled until soft, stirred until they form a smooth pulp, water added, the proper temperature insured, and by incorporating a limited quantity of malt, which stands for a brief period, the starch in the potatoes is converted into maltose sugar and dextrin. On pressing the wort or the material in a state of fermentation these soluble solids, together with the reducing sugars originally present in the tubers, are readily divorced from the pomace.

The numerous commercial varieties of sweet potatoes are adaptable to syrup-making, the color varying with the kind of potato. For instance, white varieties like Southern Queen yield a light-colored fluid while the Porto Rico and similar assortments produce syrups somewhat darker in color. Stored as well as freshly-dug tubers lend themselves to the production of the sweetening fluid—not as sweet, however, as maple or cane syrups. The intensity of the sugarness of the sweet potato product, may it be said here, is altogether satisfactory for many uses. The size of the underground root is irrelevant as far as the quality of the syrup is concerned. Herein, according to claims of the Department of Agriculture, lies the immense possibility of commercializing the newly-evolved process. Frequently forty per cent of the South's potato crop exceeds the prescribed standards of Northern markets in size, thereby rendering them well-nigh valueless for shipment. These overgrown tubers, as well as ones dwarfed in growth, yield sweetening juice equal in quality to standard market grades. Soundness is the one absolute requisite for potatoes designed for syrup-making—decaying portions, diseased tubers and other inflicted faults must be discarded.

More about the method of preparing the syrup: The potatoes are washed and hand-trimmed by way of removing dirt, bruises, and decayed portions. The tubers are then blanched (parboiled) either in boiling water or steam. Blanching, preferable to peeling, serves the purpose of removing the ingredients in the peel which would impart a green or brown color to the syrup and an objectionable flavor. The potatoes are submerged in hot water in a suitable vessel and the water quickly heated to the boiling point. A few minutes having elapsed, the water is drained off and replaced with a fresh supply. The potatoes are then cooked until thoroughly mushy in boiling water or in steam. If the latter method is pursued, the water condensed should be rejected during the first half hour of the cooking period. One hour should be allowed for the cooking, a time limitation inviting the cells of the potato to crumble whereby the malt may invade and digest the starch. Steam under pressure is unnecessary as the higher temperature does not hasten the cooking of the potato.

Once cooked, the mushy tubers are scrambled into a paste. This is accomplished by stirring, adding water until the contents of the vessel constitutes a smooth thin pulp. About two parts of water to one of potatoes is a correct proportion. The mixture is then brought to a temperature of 140 degrees Fahrenheit, a condition suggesting the introduction of the malt. One per cent of pale distillers' malt, made from barley or wheat, based on original weight of the potatoes, is added and thoroughly incorporated into the pulp and mixture, which now assumes the term "mash." It is allowed to stand, with an occasional insertion of the stirring rod. While 140 degrees Fahrenheit is an expressed preference, the temperature range is liberal—varying from 129 to 145 degrees Fahrenheit, without deteriorating effects. At this juncture the starchy contents of the potatoes are devoured by the malt, the process requiring from twenty minutes to one hour. What scientists term as the iodine test will determine the completion of this reaction, namely: A small glass funnel is equipped with filter paper and a bit of the pulp placed on the filter. When the filtrate runs clear, the drops are permitted to fall into a test tube containing a dilute—pale yellow, cold solution of iodine in potassium iodide. Each drop as it enters the solution forms a deep blue color. As the reaction with malt progresses, succeeding tests yield purple, brown, and yellow-brown colors—and, ultimately are colorless. The starch-consuming process is complete, and thus the end of the mashing period is marked.

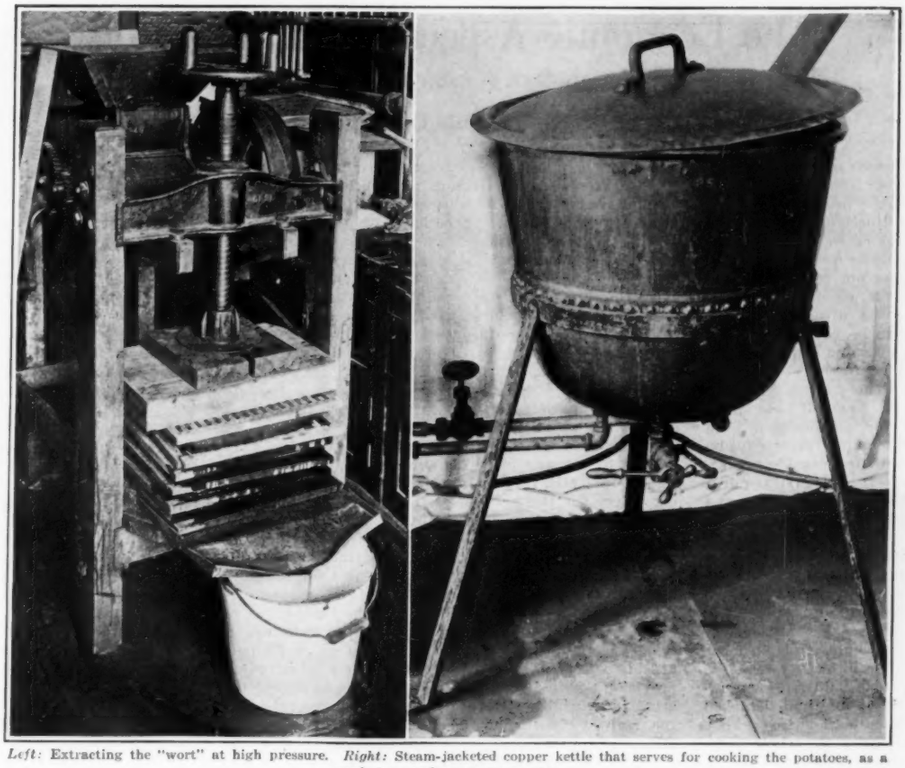
The mash drains without difficulty, and thus lends itself to a variety of separation methods. The simplest, however, is the rack-and-cloth system, well known on farms in the preparation of fruit juices. The pulp is laid up in the form of flat cakes between wooden racks, permitted to drain, and finally pressed. The equipment employed by the Bureau of Chemistry, and illustrated by the photographs which accompany this article, consisted of a screw press; a large pan of sheet tin, forming the floor of the press platform; a set of wooden racks; a wooden form for laying up the pulp; and press cloths of burlap or duck. The construction of a so-called "cheese" involves the laying of a rack on the drainage platform. The form is placed thereon and the cloth put diagonally across the form, the corners being opposite the sides. The mash is poured into this depressed "valley," and the four corners of the cloth folded over so as completely to envelop the mash. The form is lifted and another rack placed on top. The form is again put in position and another cake of mash laid up. The operation is repeated until the pile is as high as desired. Meanwhile the wort or sweet portion of the malt flows off without applying pressure other than its own heaviness. Slight force will yield a big volume of wort, while heavy pressure is ultimately resorted to. The material while in a state of fermentation is subject to visitation from microorganisms which multiply rapidly in racks, cloths and pressure platforms. The pressing equipment should be dried or kept under water when not in use, otherwise objectionable flavors may be transmitted to the syrup.

Sweet potatoes, ginger snaps and taffy are all improved by a dash of sweet potato syrup from the bottle

The sweetening fluid is now ready for table and culinary use, for manufacturing candy and as a mixing syrup. Its beautiful color is brought forth by filtering, which may be accomplished by allowing the product to stand for a day or a sufficient period of time for insoluble salts to form. Then mix about three per cent of the weight of the syrup of what is chemically known as kieselguhr and cold water adequate to easy filtration. The mixture is filtered cold as heating has a tendency to cause the concentrated salts to dissolve and make their appearance in the syrup. A plate-and-frame filter press will accomplish the job. If the raw potatoes are of first-rate quality objectionable flavors will not be present, otherwise off-flavors may appear. These can be removed by adding to the syrup somewhat diluted with water three per

cent of its weight of powdered bone char or other decoloring carbon. The mixture is heated to boiling point, permitted to stand for several minutes and the char removed by filtration. The sweetened liquid is then evaporated to the necessary density.

The yield of syrup is equal to one-third of the weight of the potatoes entering into its composition. The cost of manufacture is relatively low, and the method of preparation in home and factory is comparatively simple. The final product is an amber-colored syrup possessing a distinctive flavor — not as sweet as maple or cane syrups, to be sure. The intensity of its sweetness, however, is sufficient for a multitude of uses. Then, too, the conversion of sweet potatoes into syrup offers a big possibility in the tuber-producing South, where markets are frequently far-removed and storage facilities inadequate. All thanks to a chemical process of such transforming powers—an uncouth underground root becomes a table delicacy and contributes to the relish of gingersnaps and taffy! The various pieces of apparatus employed in extracting syrup from sweet potatoes are shown in the accompanying illustration, and one is immediately struck with the simplicity of this process. Indeed, it should come into pretty general use, not only in large sized commercial plants but on the small farm and in the home.



Left: Extracting the "wort" at high pressure. *Right:* Steam-jacketed copper kettle that serves for cooking the potatoes, as a mash tun, and as an evaporator

Apparatus for getting the biggest value out of the sweet potato

Effect of Gasoline Removal on Heat Value of Natural Gas

THE Bureau of Mines, in Technical Paper No. 253, presents details of an investigation to determine to what extent the general public and various official bodies have been justified in supposing that the removal of gasoline from natural gas greatly decreases the heating value of the latter. It has been found that in general this decrease in heating value has been overestimated. In the type of gas ordinarily supplied to the domestic consumer loss in heating power was found to be about 2 per cent after the removal of the gasoline vapor. As a rule gasoline vapor is usually accompanied by proportionate amounts of other constituents of high heating value, so that a gas high in gasoline is usually one of high heating value, even after the gasoline has been removed. Where casing head gas is involved the percentage of loss is larger, but only in rare instances does such gas reach the domestic consumer.

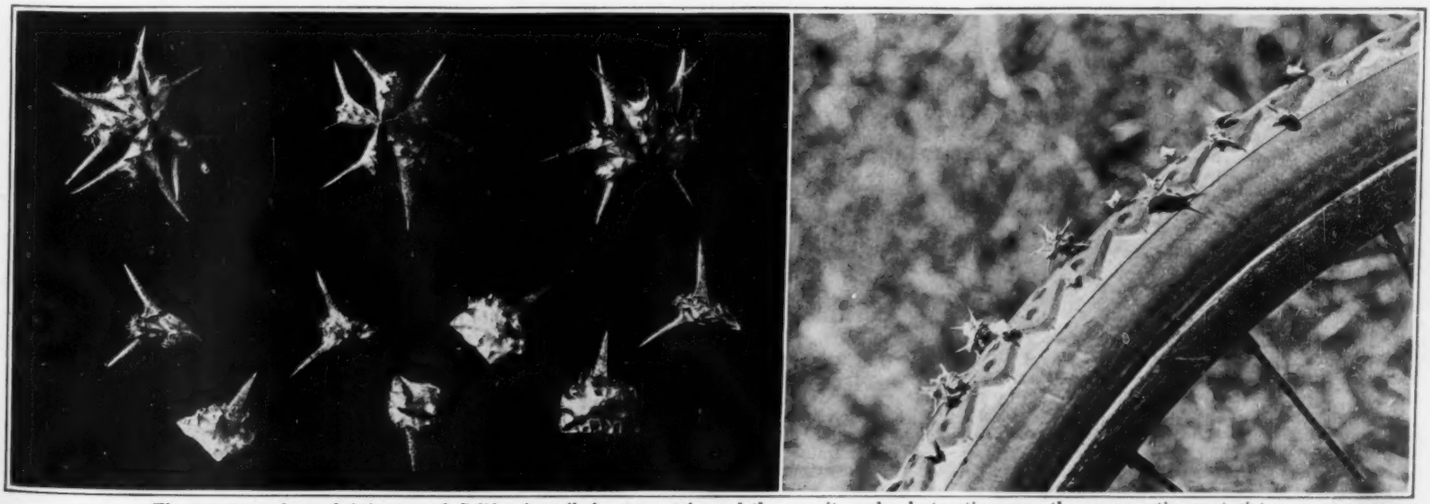
Puncture Plant Protection

IF you can imagine a roadside sprinkled liberally with tacks and needles, all lying point-side upward, ready to spread discomfort and disaster among the touring motorists and bicyclists which pass that way, you will frame a good mental picture of actual conditions existent in sections of Arizona and California where the puncture plant has been introduced and acclimated. Scientifically this weed is known as *Tribulus Terrestris* probably because it spreads tribulation and terror among all owners of inflated-tire vehicles. It is a native of southern Europe and was introduced to this country in burs imbedded in the fleeces of imported sheep. When mature, the fruits, or burs, of the puncture plants split into 5 sections, each of which is equipped with a pair of sharp spines. These sections are scattered about over the ground in such a way that some of the points are always directed upward ready to penetrate and puncture any rubber tires which pass over them.

When the spiny needles of the puncture plant are embedded in automobile tires it is very difficult to locate and remove these destructive bayonets which repeatedly prick holes through different inner tubes as they are inflated in the contaminated casing. The spiny seeds effect a double dose of damage inasmuch as they spread the infection to new sections which previously may have been unacquainted with the obnoxious plant. The seeds may be carried in automobile tires long distances and finally deposited by the roadside where they germinate and produce new plants. In addition, the seeds are disseminated widely by wind, rain, flood, spring freshet and snow. They often work their ways into the coats of market live stock or else the puncture weeds are harvested with market hay. Recently, in one way or another, seeds of the puncture plant have been introduced into Kansas, Arkansas, Texas, Nebraska, Iowa, Indiana, and Illinois, and at present the objectionable burs and spiny seeds are causing much havoc among the motorists of those regions. The possibilities for damage from this plant are well illustrated by the experiences of a California motorist who reported 70 punctures in one tire, all due to the puncture vine. In some sections where the puncture plant has become established, one-half of the bicycle tire and approximately one-quarter of the automobile tire punctures result from the spiny burs of this plant which are distributed along the waysides.

Fortunately, the puncture plant is an annual and on tillable ground, it can be controlled by repeated cultivation which prevents the formation of seed. Along the roadsides, where the weeds are most dangerous from the standpoint of the motorists, mowing has been resorted to unsuccessfully as an eradication expedient. The vines grow so low and spread so close to the ground that it is impossible to cut them off satisfactorily with the mower before they form seed. Furthermore, many of the plants which are clipped will subsequently produce burs and seed the same season. The national agricultural authorities are now testing out the effectiveness of iron sulfate and crude oil sprays for destroying the puncture plant. Potentially, they expect to perfect control measures which will minimize the motoring dangers due to the puncture plant, the unwelcome emigrant which reached our shores by stowaway methods.

The illustrations below give an excellent idea of the general appearance of the puncture plant's opening seeds and how they imbed themselves in the soft rubber surface of automobile and bicycle tires.



The puncture plant of Arizona and California, tribulus terrestris, and the way it works destruction upon the unsuspecting motorist

The Economic Aspects of Mobilization

What It Means to a Modern Nation to Put an Army in the Field

By Jennings C. Wise

MOBILIZATION, or the first phase of war, although for an uneconomic purpose, from an economic standpoint should be regarded as a problem involving the translation of potential into kinetic energy. In the process no new force should have to be created. The stored energy should merely require to be converted into a moving force, for time does not permit the generation of new energy after the emergency arises.

Efficiency in warfare cannot be attained without economic efficiency, and there can be no economic efficiency if the economic factors of supply and demand be ignored. Supply in a country possessing so vast and diversified a wealth as that of the United States is largely a matter of transportation, hence it is asserted with confidence that no plan for mobilization is a practical plan which ignores the existing transportation facilities and the problem which their scientific utilization in an emergency presents. Its solution requires the best brains and the best efforts of the Nation, and in that solution every department of Government must be employed; in the future the entire cabinet must act as a General Staff Committee upon mobilization.

The most casual investigation will show that our industrial mobilization was seriously retarded by reason of a complete failure on the part of the Government to provide in advance for the coordination and efficient utilization of our commercial and industrial agencies. Failing to perceive the essential relation between the mobilization of our manpower and industries, an attempt to deal with the former singly and in a detached way, rendered the industrial mobilization for a time impossible. The initial mistake threw the whole country into a state of economic chaos from which it has not yet been extricated. The financial loss which this entailed cannot be computed, some of the more apparent results being the worn-out condition of the railroads, a huge waste upon a non-existing emergency fleet, the unnecessary high cost of living, and an enormous and disproportionately increased debt in comparison with that of other countries.

The damage to the railroads resulted from their misuse and abuse, and the disastrous effect upon the economic life of the country from a complete disregard of the economic principles involved in the balance of supply and demand, both of which might have been avoided in large measure.

The continental territory of the United States may be roughly divided into two areas with respect to industry, food, forage and fuel production and the transportation systems serving it. The first area comprised of the states of Illinois, Michigan, Ohio, Indiana, Pennsylvania, Maryland, Delaware, New Jersey, New York and the New England States is essentially an industrial and non-surplus food, forage and fuel producing area, within which are located the vast majority of the manufacturing plants of the country, and at least 95 per cent of those adaptable to munition production. The remaining territory constitutes a vast surplus food, forage and fuel-producing area, non-industrial and essentially agricultural in nature, and depending upon exportation for the absorption of its surplus production. The economic life of both areas is dependent upon the railway systems within them. The first imports food, fuel and forage from the second, and exports its manufactures to the latter and to foreign markets. The second, while not essentially industrial, is industrially self-sustaining, but absolutely dependent for its wealth and economic stability upon the export of its surplus of food, fuel and forage.

At the beginning of the late war, despite years of warning, the railroads were not only not prepared to meet the altered circumstanc s which the emergency of war developed, but were for a time unable to develop their normal industrial capacity. The cause of this breakdown in our National transportation and industrial systems is readily discernible.

In the industrial area the population was suddenly augmented with a consequent increased demand for food, forage and fuel, while the normal supply of these commodities was diminished through the inability of the railroads to handle them, the railroads for the time being wholly employed in the transportation of troops and their supplies. Prices were, therefore, inflated by this disturbance of the economic balance of supply and demand, coupled with which was the wild extravagance of the Government in connection with the labor wage for Government work. Coincidently the draft decreased the supply and the war needs increased the demand for labor.

On the other hand the population of the agricultural area decreased coincidently with an accumulation on the hands of the producers of the normal surplus of food, forage and fuel, exportation being interrupted by the lack of transportation facilities. In this area, the surplus being in excess of exportations, an immediate stringency in ready money occurred, though the wildest speculation was encouraged by the frenzied markets of the industrial area and foreign countries which were willing to pay any price for supplies of food, fuel and forage, thus still further inflating prices. With increasing prices for the necessities the labor wage mounted higher and higher in both sections.

So soon as war was declared, and not before, innumerable agents of the War Department were despatched about the country to select sites for the military cantonments. This was done wholly without regard to any preconceived plan and the limitations of the transportation system of the country as a whole. Congressional political influence played no small part at this time, so that at the very crisis when every provision possible should have been made to relieve the great industrial system of transportation comprised of the railways north of the Potomac and east of the Mississippi River, enormous new populations were deliberately created within that area, at Camp Devens, near Boston, Camp Upton and Camp Mills near New York, Camp Dix near Philadelphia, and Camp Meade near Baltimore, all within the most complex and intricate industrial region and athwart the most vital link of railway in America.

HERETOFORE mobilization has been regarded in this country as a matter wholly within the province of the War Department, but it must now be apparent to everyone that mere segregated aggregations of combatants will no longer suffice for war, and that armies may not be assembled as of yore without serious interference with the social and economic life of the State which furnishes them. Our late experience has taught us that the whole people must now be mobilized along with their material resources. So, too, the time has passed when failure to coordinate the commercial, industrial and military programs merely involved duplication and unnecessary expense. Under the complex social and economic conditions of the present the three must be considered conjointly, not alone for the sake of a saving in money and effort, but in order that the economic organization of the belligerent State may be made to serve efficiently the war machine. In this article, Mr. Wise tells us what this ultimately means.—THE EDITOR.

The natural consequence of the astonishing error was that during the period of readjustment of the railways to the burden of troop transportation and supply, the industries of the East were stalled. Every port on the Atlantic coast immediately became choked, and the entire railway system of the country felt the evil effects of the almost hopeless congestion along the Atlantic Seaboard. No effort whatever was made to relieve the railroads of their excessive burden by an intelligent use of the priceless coastal shipping communication between the Atlantic and Gulf ports for the purposes of troop movements and troop supply.

It almost seems that some perverse fate blinded the Government in the crisis to that which is now clearly apparent. A study of a railroad map will show that within the area east of the Mississippi there are two distinct systems of railroad communications viewed with respect to their origins and termini. The first originating at Chicago and St. Louis, spreads like a net over the industrial area, focusing at New York. This system is essentially industrial, like the area which it serves, and if the Seaboard link between Boston and Washington, or the pulmonary artery of industry, be overstrained the entire system will be paralyzed. This system, then, is vital to industry, and since a complete industrial mobilization is vital to success in war, everything possible should have been done to relieve it of unnecessary burden. Obviously no cantonments should have been created within the industrial area.

The second system originating at Chicago, St. Louis, Memphis, and New Orleans, touches the Atlantic coast at the ports of Jacksonville, Savannah, Charleston, Wilmington and Norfolk, focusing at Petersburg, Va., in the strategically vital region of the lower Chesapeake. The surplus food, forage and fuel producing area within which this vast system lies is wholly separate and apart from the industrial area to the north, yet bound to it by the north and south trunk lines of the Mississippi Valley and the Atlantic Seaboard and the two parallel intervening lines passing southward from Cincinnati. By means of these excellent connections the products and population of the two areas could have been freely interchanged without interruption to the east and west flow of traffic, the entire region beyond the Mississippi being equally accessible to either area by reason of the common bases at Chicago and St. Louis. The east and west lines of the southern system were in no sense essential to the industrial area and, therefore, should have been utilized for the movement and supply of troops. The withdrawal of the military population of the northern area and its distribution in the southern area would have created new markets for the surplus of the latter and at the same time would have counterbalanced the increment to the industrial population.

The advantages of the southern over the northern area with respect to the length of the training season, the lower cost of fuel, and the saving of transportation tonnage which is to be effected through the lower fuel requirements of the troops are obvious. It is apparent that the cost of training a given number of men would have been less in the southern than it was in the congested industrial area. With all the cantonments located south of the Potomac and Ohio Rivers, the contingents from New England, the region of New York City and New Jersey, could have been moved southward by coastwise shipping, leaving the rail communications of the Atlantic Seaboard free for industrial purposes; those from western New York and Pennsylvania, from Harrisburg and Pittsburgh, southward via the Norfolk & Western Railroad; those from Illinois, Michigan, Ohio, and Indiana by the Chesapeake & Ohio and its southern connections. Richmond and Petersburgh were the logical points for the distribution of troops along the southern seaboard, by the Southern Railroad, Seaboard Air Line and Atlantic Coast Line. From St. Louis and Cincinnati the more western contingents from the northern area could have been distributed southward. Meantime the entire railway system of the industrial area would have been functioning with its east and west lines free of troops, and without an excessive burden.

The lesson to be derived from our recent experiences is that a mobilization plan must be prepared in advance of mobilization, and this plan must coordinate the commercial, industrial and purely military factors if the best results are to be derived during the war as well as in the days of peace that must follow.

The rail communications between St. Louis and Chicago, Cincinnati and Louisville, Cincinnati and Atlanta, Washington and Richmond, and Philadelphia and the lower Chesapeake must be kept free of fuel traffic, by setting apart the coal fields of Pennsylvania to the northern, and the coal fields of Virginia and West Virginia to the southern area, and the region west of the Mississippi, while the coastal shipping must be so organized as to relieve the north and south rail communications of the Atlantic Seaboard of the maximum burden possible. The food and forage drawn from the grain and beef-producing regions of the west must be introduced into the northern area at Chicago and St. Louis, and into the southern area at St. Louis, Memphis and New Orleans, with Kansas City as the common distributing point. Thus will the problem of mobilization be solved with a minimum of disturbance to and dislocation of the economic life of the country, and a maximum of ease and expedition in the trying days of mobilization.

Rapid Transit Arithmetic

The Principle of the Economic Unit Applied To Large Cities' Utilities

By John Lathrop

WERE the statement printed broadcast in the United States or in Great Britain that "the principle of the economic unit, as applied to construction costs and operation of transit lines in large cities, entailed an inevitable increase of passenger fares," the mass of the people would not understand the meaning of it. And yet, by open and frank discussion—by interpreting this well-known engineering principle so that "the men in the street" could understand it, Lord Ashfield, managing director, and Mr. Frank Pick, assistant managing director, of the London County tram, underground and 'bus lines, achieved that which might have been regarded as impossible.

The increasing of base fares in the Zone system there from one penny (two cents) to one and one-half pennies (three cents) with virtually no complaint by the people. That this was an achievement, that the one-penny base fare was almost so sacred a tradition in England as Magna Charta, the parchment of the original of which rests in the British Museum, must be freely conceded. Post-war burdens had been piled on the British people until they staggered under the colossal whole.

When, therefore, the suggestion was advanced that transit fares must be increased fifty per cent, else the companies would be compelled to retain the Government guarantee, or be insolvent, loud protest was registered by certain writers who seize every opportunity to prejudice public opinion on all matters in respect of the people's utilities.

However, before these protests assumed considerable volume, the managing director, Lord Ashfield, who is American-trained in railway science, asked his assistant managing director, Mr. Pick, who also is American-trained, to take up the frank discussion with the people, through legitimate advertising channels, of the precise situation of the companies, explain why increased fares were necessary, and that, unless they were granted, it would be necessary to continue to find financial backing from the Government, in order to carry on the service and new commitments essential to continued operation and the supplying of the people's service needs.

Mr. Pick called in his publicity experts, laid before them the scientific principles involved, and told them to go to the people with their arguments. Preliminary objections publicly expressed had been, as expected, among the line of "watered stock," "selfish corporationists, and so forth.

The publicity men proceeded, first, to elucidate to the understanding of the average person the practical out-working of the principle of the economic unit. They showed how, as a city grows toward a certain magnitude, the economies are preserved, and costs of public utility in construction and operation are reduced per unit. They went on to show that, after the city has grown beyond the limit of economic size, costs, instead of being lessened per unit, are inevitably increased; that it costs more per passenger to build and operate in a city of a million population than in one of a hundred thousand; and that, when population mounts to the six millions of London or New York, the economic limit has long since been passed, and costs per unit are vastly more than when the city was small. The involvement of the mechanical works—the intricate network of pipes, conduits, sewers, watermains, telegraph and telephone wires, the heavy and permanent pavements—entailed inseparably higher costs. The growing congestion in the streets, especially after the popularization of the automobile, likewise prevented the economies which the mass of the people believed were possible in a larger city, and added to the passenger-mile costs of operation. The general increase of cost of supplies and materials, they showed, was 150 per cent. For instance, cars which cost two thousand pounds pre-war now cost seventy-five hundred pounds—an increase of 275 per cent. And so on *ad finitum*.

The arrangement was effected with the Minister of Transport that on September 20, 1920, the Government guarantee should be abandoned, the fares be increased from one-penny base to one and a half pennies, and the companies would stand on their own footing financially, meeting their charges from their own revenues, and asking no aid from the public treasury.

I talked with Mr. Pick at the companies' headquarters in Electric House, Westminster, after the report had been prepared by Lord Ashfield for submission to his stockholders. "How extensive was the volume of protest?" I asked.

"We have here," he answered, pointing toward the letter files, "every written protest which we received. I should be glad to show them to you. There are six millions of persons in London district served by our lines. And we received exactly forty-two letters of protest!"

That, of course, was negligible, especially when the total volume of traffic be taken into account as revealed in Lord Ashfield's report:

Car-miles of the entire system, 179,000,000; an increase of 19,000,000 during the year.

Trackage, 753; underground, 105; trams, 124; omnibuses, 524. Passengers carried, 1,487,000,000; underground, 404,000,000; trams, 210,000,000; omnibuses, 873,000,000; total increase over previous year, 110,000,000.

These increases were forced upon the transit lines by the conditions of city life there which were duplicated in every large city, and in many smaller cities, in all countries during and after the war. And, with fares remaining at the traditional one-penny base, so Lord Ashfield observed in his annual report, "the very success of transport companies in attracting and creating passenger traffic was a burden to them. Since then (the increasing of the fares) the situation has changed radically for the better."

This improvement in the financial status of the

(*Continued on page 190*)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Old Thought and New

To the Editor of the SCIENTIFIC AMERICAN:

Professor Eddington appears to assert that there are absolute things as matter, and that force is purely relative; and also that matter is merely a symptom, and the reality is the field of force. (Space, Time, and Gravitation, pp. 42, 76, 165, 191, *et passim.*) Doubtless by a universal theory of relativity, as distinguished from the special and the general theory, these discordant positions could be harmonized. But it is difficult for the "exoterikoi" to penetrate to the underlying verity.

It is vastly amusing to see the materialists (of whom I am one) giving up matter as an ultimate reality. In taking perhaps a final leave of this supposititious and degraded entity, it is interesting to consider some of the views entertained of it by men preeminent for power of thought throughout the ages.

Plato called a material object a shadow of the real. Gorgias of Leontinum went him one better, and asserted it to be a particular instance of that which is not. Heraclitus before him, an example of generation and corruption, of a passing from not-being through being to not-being again. Democritus, a fortuitous, or necessitated, or self-determined concourse of atoms. St. Augustine, harking back to Heraclitus, a temporality of the Eternal. The schoolmen, a group of transitory, varying accidents inhering in a perdurable, unchanging hypostasis. Berkeley, a group of visible and tangible phenomena not manifested by an underlying substance. Descartes, an extended, inert entity occupying space. Leibnitz, a congeries of unextended, energizing monads. Spinoza, a modification of the divine substance. Kano, a manifold of intuition. Hegel, a figment of the consentient. Hamilton, a mode of the unconditioned. Mill, a permanent possibility of sensation. Spencer, a manifestation of the unknowable. Emerson, a projected phenomenon of the intellect. Francis Bowen, a locally limited portion of space endowed with the principle of causation. This last would seem to include the latter day view, the nucleus of a gravitational field.

Present opinion seems to be that our notions of space and time are derived from our experience, personal and ancestral, of material objects. Of space and time all possible views have been held, none of them free from very grave difficulties. They are things, objective realities, conditioning all other realities. They are relations between things. They are relations between things and states of consciousness (forms of intuition). They are *entia rationis*, figments of the reason as distinguished from figments of the imagination. I should think some of the absolute idealists must hold them to be relations between states of consciousness.

It is very early to predict that the latest theory will give the final victory to a modification of one of these views. It seems to me that the space-time continuum is needed, not as a relation, but as a correlative of the discretum, the changing material universe.

Ashland, Mass. W. C. ROSE.

An X-Ray Innovation

To the Editor of the SCIENTIFIC AMERICAN:

While experimenting in an effort to X-ray or radiograph documents and objects of a like nature, we have made a rather interesting discovery, the product of which we have designated as "Flurographs."

The original negatives were made by placing the check or other document between two fluorescent screens while in contact with an unexposed X-ray film. An X-ray exposure of this combination which was tightly clamped in a light-proof cassette was then made with the resulting negatives. Development of the exposed film was the routine development for X-ray exposures as made in the medical laboratory.

At first it was thought that a true radiograph had been made of the exposed document but further experiment demonstrated that the best negatives were made by means of an X-ray exposure entirely too intense and penetrating for such a slight object as a sheet of paper. Endeavors to X-ray documents without the use of the double fluorescent screens, which in medical work are used simply to intensify the action of the X-ray and thus shorten the time of exposure, were entirely without result. We finally came to the conclusion that these negatives were produced entirely by the action of the fluorescent light set up in the intensifying screens which were in turn activated by the recognized action of the X-rays upon their structure.

Blurring of certain portions of the samples submitted is due to our inability as yet to obtain a holding cassette with sufficient compression to secure perfect apposition of the document and the film. Contrast between the paper and the printing can be further intensified by refinement of the technic of X-ray exposure. These films were taken with an exposure of 20 milliamperes, an intensity of current represented by an air spark-gap of 4½ inches, distance of 36 inches and time of ¼ second.

Practical uses of this process may include commercial reproduction of documents and other papers, the detection of changes in checks and bank notes and a means of measuring and standardizing the fluorescent action of intensifying screens.

Portland, Ore. DR. J. A. VAN BRAKLE.

Poles and Miles

To the Editor of the SCIENTIFIC AMERICAN:

In your Correspondence for August 27, a writer mentioned timing a train with a watch and it occurred to me that the rule for obtaining the speed of a train direct from the watch without any calculation would probably be of interest to your readers.

This rule is very simple and still very accurate. Note the spacing of the telegraph poles. They are usually 34 to the mile. Watch for a straight stretch. Count the poles that you pass in 106 seconds, the number of poles will be the number of miles per hour that you are going.

This rule was developed from the old "count the rails" method that is absolutely useless for taking high speeds. The germ of the idea is the same, however, though it is much easier to see the poles than to hear the "clicks."

Both methods depend on a knowledge of the lengths of the elements. Where mile posts are marked the spacing is easily and quickly found. Should the spacing be other than 34 the number 106 must be changed accordingly. This is easily done by finding the number of poles in two miles, and then finding the number of seconds it will take to pass 60 poles at a speed of 60 miles per hour. For example, 30 poles per mile, 60 poles in 2 miles. It will take 120 seconds to pass 60 poles at 60 miles per hour, therefore use 120 instead of 106 and read the poles as miles as before.

Buffalo, N. Y. ROGER J. SWEET.

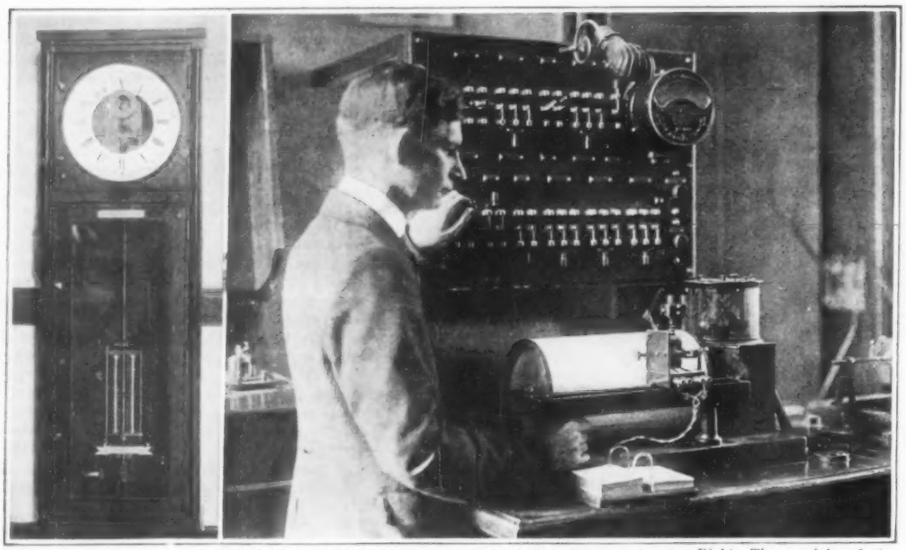
From Star to Chronometer via Radio

The Function and the Manner of Transmission of the Modern Time Signal

By C. H. Claudy

IT is a curiosity of scientific progress that the discovery which makes a new art possible is so often discarded as the art progresses; the warping wing which was the basis of the Wright's flying machine, and which made mechanical flight possible, is not now used: the Gallilean telescope is no longer in the armory of the astronomer, and the chronometer, which, with the sextant, made the science of modern navigation possible, is rapidly becoming more a convenience than a necessity.

The warping wing gave way to the most simple and easily controllable aileron, Galileo's concave eyepiece was displaced by the modern high power convex optical combination, and while accurate basic meridian time is just as essential to longitude determinations now as then, the chronometer gives it to ships at sea with neither the convenience nor the accuracy of the all-but-instantaneous radio.

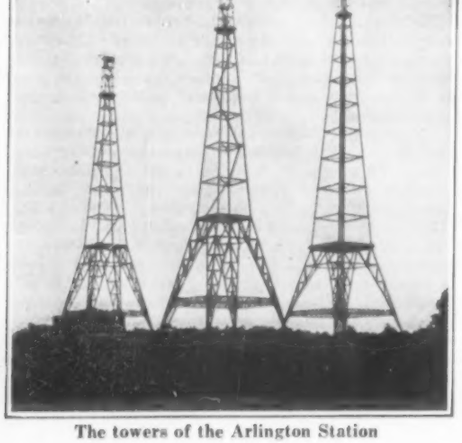


Left: The chronograph on which the signals are tested and regulated before being sent out. *Right:* The pendulu of the transmitting clock, with the magnet beneath it

The United States Navy has developed the transmission of the basic meridian time by means of radio to a point where it is not only used by every mariner in the northern hemisphere who has a radio set upon his vessel, but to the great convenience of surveyors, jewelers, amateur radio operators, astronomers and scientific workers of many kinds, including, of course, those engaged in the accurate determination of longitude on land.

Easily to comprehend the system by which Washington or Mare Island time is sent out twice daily *via* radio, it will be necessary to glance briefly at the familiar process by which time has been sent out over land wires for many years.

The basis of time is the revolution of the earth about its axis, which revolution is measured by a never-ending series of observations of time stars, through a transit or meridian circle instrument. At the Naval Observatory at Washington and the Time Station, Mare Island Navy Yard, California, there are most accurately made and carefully guarded standard clocks, set on heavy concrete pillars in vaults beneath the surface of the earth, running in a partial vacuum at a constant temperature, wound every thirty seconds by electricity, provided with pendulums of invar (which neither expand nor contract) and removed from jar or disturbing influence of any kind.



The towers of the Arlington Station

Making sure that the time signals beat true second

Man has never yet been able to construct a mechanism which keeps truly accurate time: some error, no matter how small, is always observable in a sufficient time to allow that error to accumulate. But he has been able to construct mechanisms the error in true time of which is reasonably constant. This error, plus or minus, is known as the "rate" of the clock or chronometer, and if the true "rate" of any time-keeping mechanism is known, substraction or addition will give the true time. It is to determine the rate, and its changes, if any, that continuous observations are made on clock stars every clear night at Washington and Mare Island Navy Yard.

By arrangement with the telegraph companies, their wires are cleared of all other business at five minutes of noon every day, in order to permit the sending of time signals. These signals are sent as a beat, every second, omitting the 29th second and last five seconds of every minute, and a wait of ten seconds just prior to noon.

The time is taken from the standard clock and put upon the wires by means of a transmitting clock, a mechanism which is but a fine clock movement, designed to make an electrical contact on the beginning of each second, and with an interesting apparatus, to be described in a moment, by means of which it may be slowed or speeded up.

Shortly before the time signals are to be sent out, the standard clock and the signal sending clock are both thrown into circuits with recording pens upon a chronograph. The simultaneous record of the second beats of both clocks shows immediately how much off the true beat is the transmitting clock. Immediately beneath the pendulum of the transmitting clock is an electric magnet through which current may be passed in either direction. One polarity adds to the pull of gravity the additional pull of a magnetic attraction: the other polarity will subtract from the gravitational pull a magnetic repulsion. The effect of the one is to accelerate the clock by four one-hundredths of a second (about) in a minute's use of the magnet: the effect of the other is to retard the clock by a similar amount. By use of this delicate retarding or accelerating device the operator is able exactly to synchronize the sending clock and the time clock. The signal transmitting clock is connected with the wires at five minutes before noon and beats out the seconds for all the country east of the Rocky Mountains. A similar service is performed for the Far West by the Mare Island apparatus.

The same signals are sent out to the greater parts of the world by means of radio. Radio time signals are sent twice a day, at noon and at 10 P. M. (Washington time). They are to be heard anywhere on the Atlantic or Pacific north of the equator and to an unknown mileage south of it, depending upon the atmospheric and electric conditions, the delicacy of the receiving apparatus, the orientation with the radio wave of the receiving attenna, etc. It is thus that ships are made independent of their chronometers.

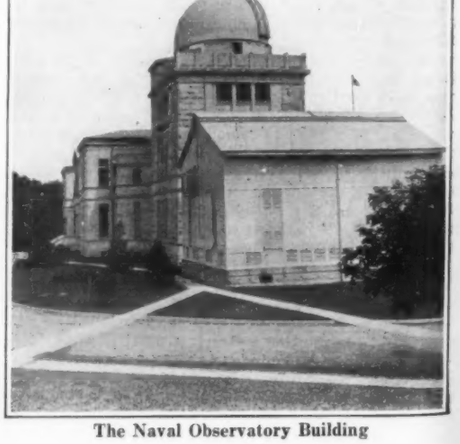
The determination of longitude is the determination of the difference between local time and time of some other locality. The world uses Greenwich, England (0 Meridian) as the standard. The navigator determines his local time by a sextant observation of the sun, a star or a planet, marking the time of the observation by his timepiece which he compares with his chronometers. His chronometers allowing for known errors give him Greenwich time. The difference between the local and Greenwich time is his longitude, each hour being equivalent to fifteen degrees, each four minutes' difference one degree, etc.

The importance of accurate meridian time on shipboard is vital. If the chronometer is "out" the reckoning is also "out" and a ship which doesn't know where she is may be, often is, in deadly danger. When ships depend upon chronometer time, three are carried; if dependence is placed in but one there is no way of telling if it varies; if two are carried and one varies there is no way of telling which one, but three tell tales upon each other. Even three, or any number of the chronometers, however, may fall into error, and no matter how accurately they are made or how carefully compared and rated on shore, the movement of the vessel in the waves, changes of temperature and barometric pressure, the vibration of the hull due to machinery may, and often do, introduce disturbances in the rate. In a long voyage the errors in the rate may be material.

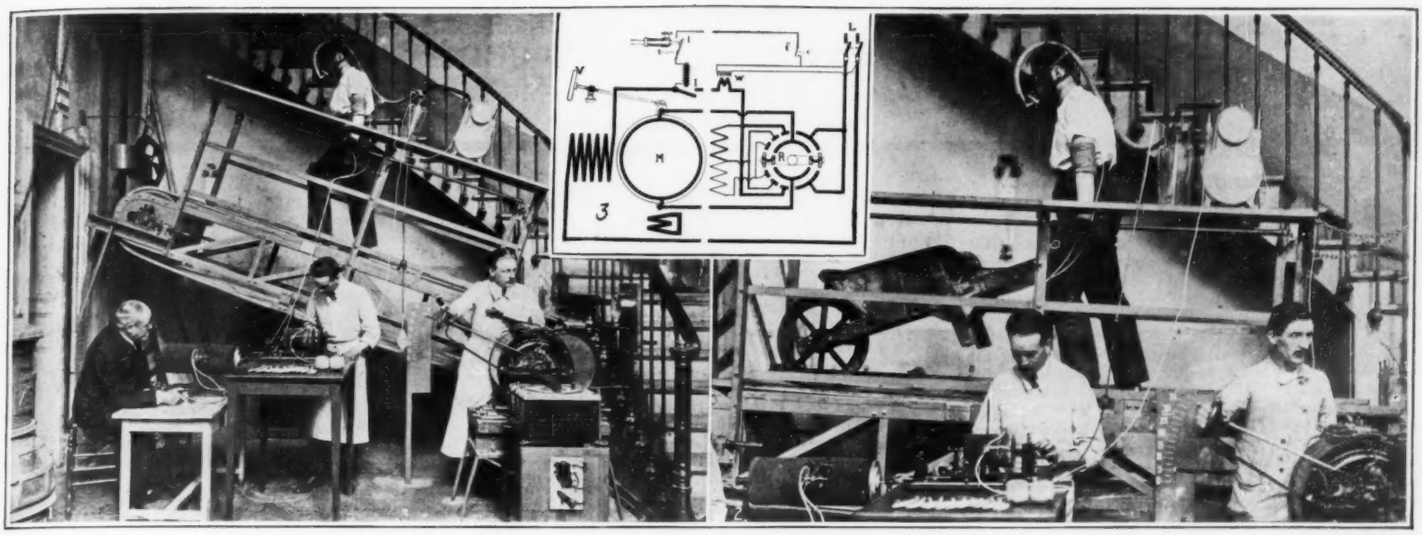
But with a twice-daily radio time service, the chronometer, from being the very heart of the ship, becomes of little more service than a first-class watch. It is a poor time-keeping mechanism indeed which will not run with reasonable accuracy for a few hours, and with true Greenwich time received twice a day, that is all the navigator demands of his chronometers.

Radio time signals are sent out not from one or two but from fourteen stations. These are Washington, Annapolis, Key West, New Orleans, Balboa, Colon,

(*Continued on page 192*)



The Naval Observatory Building



Left: General view of the man-testing apparatus developed by Prof. Langlois as it appears during a test. *Right:* Near view of the moving platform during a test to determine the energy expended in pushing a wheelbarrow up a slight grade. Note the devices for testing the lung action on the shelf to the rear of the subject, and the sensitive devices for making graphs on smoked cylinders in the left foreground. *Insert:* Wiring diagram of the electric motor which drives the moving platform

General view and some details of the man-testing equipment used by Professor Langlois

Testing the Human Machine in the Man-Testing Laboratory

SIMPLE as the art of walking appears when one has become proficient in it, it is really quite a complex function from the point of view of the physiologist. Not only muscles, bones, and tendons are concerned in it, but such other factors as the condition of the heart and arteries, the rapidity and depth of the act of respiration, and the coordination of muscles which depends upon the smooth action of the reflex nervous system.

The usual method of observation has consisted in causing the person examined to walk for a definite distance, stopping from time to time so that the examiner may take his temperature and his arterial pressure, and collect a sample of expired air. This method, however, is obviously very imperfect. For one thing, under such conditions the subject is not really examined while actually walking, but only during brief resting periods. This makes it difficult if not impossible to study such features as the slowing up or stopping of the motion, the curious phenomenon known as getting a second wind, and the rapid and sometimes violent reactions which take place during the first few seconds after the motion ceases.

Naturally enough it occurred to physiologists that some sort of a device, such as a treadmill enabling the subject to walk without changing his position, would be an improvement.

These considerations led the French physiologist, Professor Langlois, to attempt to construct an apparatus having a variable slope and, at the same time, big enough and strong enough to support the weight of several men, while still flexible enough to permit of considerable variation of rapidity. Under the auspices of the French War Department he undertook to have such an apparatus constructed in order that the knowledge of physiological action obtained might be made a basis for the physical training of the men. The apparatus is shown in our cover illustration, as well as in the accompanying illustrations.

By the aid of a well-known engineer named Hallé, an authority on the escalators or moving platforms used in the big French department stores, he succeeded in devising a suitable apparatus, namely, one in which the velocity can be made to vary within rather wide limits, and with a slope that can be modified so that inclines ranging from 0 to 35 per cent may be obtained. Furthermore, the movement may be reversed so that the subject may be examined when walking downward as well as when ascending. Again, there are a number of safety devices to prevent all danger.

As now in use the escalator or endless platform resembles those commonly used in the department stores, except that it is not used to assist the progress of the person walking but to keep him in the same spot while moving his legs.

The platform is made of chrome leather and is 25 mm. thick; it is formed of leather thongs 25 mm. wide, placed side by side. The carpet is 8 m. long and 60 cm. wide; it is stretched between two wooden drums, 52 cm. in diameter, one of which is fixed while the other moves freely. The distance between these two drums is 3.18 m. from one axis to the other. The useful length of the carpet is about 2.80 m.

The two bearings of the axle of the freely moving drum are mounted on shoes or sockets and are controlled by two screws which move them backward and forward in the same manner as the screws which regulate the rear wheel of a bicycle. This makes it possible not only to regulate the tension of the platform but also to suppress the parallelism of the axes of the two pulleys. A platform so short as this has, of course, very little elasticity, and it is impossible to obtain an equal tension of the two edges. This inequality of tension tends to make it slide upon one side of the pulleys; but in order to keep it in place it is only necessary to vary the orientation of the axis of the free drum.

Between these two drums the platform rests on a polished oak floor upon which the weight of the subject bears while he walks. At first large quantities of talcum are used to reduce friction, but gradually the two surfaces in contact polish each other so that they slide without difficulty. The carpet is drawn along by the fixed drum wedged upon a shaft which rests upon two stout bearings. A 5-horsepower electric motor, shown at the right of both illustrations, drives the moving platform in the reverse direction to the walking subject.

The electric motor is connected in series and its functioning is analogous to that of a series motor operating on direct current. In this instance single-phase alternating current is employed, together with a brush and commutator arrangement which may be varied to permit of a wide range of speeds. The motor is of the four-pole design. Its fixed portion bears two windings; the first is closed in a short circuit upon itself, its axis following the normal direction of the line of the brushes, while it acts as a compensation for the field of the induced current. The second winding, whose axis is perpendicular to the line of the brushes, serves to start the motor; it is mounted in series with the induced current. The speed is regulated by means of a hand-wheel on the frame of the motor. The subject of the experiment can stop the motion of the apparatus merely by pulling backward the right-hand rail.

A wattmeter shows the power absorbed by the motor, a tachymeter gives the speed of the motion of the carpet, and the degree of inclination of the apparatus is indicated by an arrow moving over a graduated dial.

The efficiency of the human machine is comparatively high, we learn from Professor Langlois' experiments, amounting to 33 per cent in well-trained individuals. But we must consider not efficiency alone, but the effect on the body, and here the heart action is significant. The Langlois apparatus enables us for the first time to obtain a record during the very act of walking, of the rhythm of the heart and of the blood pressure; we can observe further the increase of temperature, variations in the state of the tremors of the body, and even (by X-rays) the form of the organs, especially the contraction and expansion of the heart during the exercise.

Professor Langlois' experiments are specially meant for the purpose of studying soldiers, students, and laborers. They will answer such questions, for example, as whether the greatest efficiency can be had by pushing or by dragging a load, and what is the most economic load for a man of given height and weight, for a given slope, etc.

Trucking Milk Long Distances Without Spoilage and at Lower Cost

A SAN FRANCISCO milk distributor, reaching far back into the country to obtain an adequate supply, found that the success of the enterprise turned on transportation. The railroad was used at first, but the carrier could furnish only baggage cars, which had ventilators in the forward ends. What with heat, and bacteria, the milk arrived in poor condition. From the shipping point, Soledad, to San Francisco, was 134 miles, and though no Coast distributor had ever trucked milk that far, the company decided to try it.

Solving certain serious problems, the distributor put the enterprise over with all-round success.

The first, and most serious problem, was the churning of milk in the tanks. There would be so much of this over the long route that city milk inspectors declared the milk would arrive unfit for sale. They were so certain on this point that they were right on hand to inspect initial shipments.

The company mixed and cooled the milk at Soledad to a temperature of 36 to 40 degrees. On arrival in San Francisco, even in the hottest weather, its temperature was not greater than 45 to 48 degrees. Thus the milk throughout the route was kept too cold to churn or spoil. The maintenance of the temperature throughout a long trip—one truck used takes 10½ hours, the other about 12 hours—was accomplished by covering the ten-gallon milk tanks with three layers of wet sacks, and throwing a tarpaulin over all. The sacks are wet as required en route.

As suggested this was the greatest obstacle to truck haulage. Another difficulty was caused by a feature of the route, the San Juan grade, crooked and steep. The trucks carry large loads. One truck's average load is 278 10-gallon tanks, the other's 260 tanks. Trailers are used. The problem of the San Juan grade was solved by employing a 2½ ton truck, stationed at Salinas, to haul the trailer to the top of the grade each day.

Under the particular conditions, the truck method actually effects a minimum 20 per cent saving in transportation cost, to say nothing of the milk arriving in better condition. The railroad charge was 50 cents a tank. Figuring all charges of labor, gasoline, depreciation, the distributor figures 40 cents as the maximum cost with truck. On every day's load of milk transported there is a saving of $28 made.

The milk is collected from the producers at Soledad by small trucks. The big trucks leave for Frisco around noon.

The Service of the Chemist

A Department Devoted to Progress in the Field of Applied Chemistry

Conducted by H. E. HOWE, Chemical Engineer

Cooperative Analysis

THE American Oil Chemists Society has issued a cooperative analytical program for 1921-1922. The purpose of the work in question is to provide reliable means to assist chemists in discovering to what extent their organizations are working with accuracy, and in case accuracy is deteriorating, to locate and eradicate the cause. This same purpose is accomplished in some other industries by the use of standard samples such as the standard iron and steel samples supplied by the Bureau of Standards. The materials with which the oil chemist works, being unstable, cannot be standardized in the same way, and so the society is undertaking another method of standardization which seems to satisfy the requirements. No labor or expense is spared in preparing uniform samples, and in years past more than one hundred analysts have collaborated in the work. The sample groups include meal, fertilizer, fat samples, and crude oil. Standard methods of analysis are followed and the samples are sent out at stated predetermined intervals to all those cooperating in the program. At the completion of the work suitable recognition will be made for meritorious work. The analyst whose total average efficiency on the forty meal samples for both oil and ammonia is highest will be awarded the silver laboratory cup. In addition to this certain certificates will be given for meritorious work in the other groups.

The society for the past six years has conducted collaborative work on the analysis of meals heretofore known as the check meal work; but this is the first year that the activity has been extended and a booklet has been issued for the purpose of interesting as large a number of analysts as possible.

Preventing Mold and Decay in Wood Pulp

SERIOUS losses are caused in wood pulp during storage due to mold and decay which condition has led the Forest Products Laboratory to undertake experiments to determine the relative suitability of preservatives which might be used to prevent these losses. In considering preservatives, account was taken of their effectiveness as antiseptics, poisonous properties, tendency to discolor the pulp, objectionable odor, solubility in cold water, and cheapness. All in all sodium fluoride appeared to give the best results, and a 5 per cent solution sprayed on the pulp at the rate of eighty pounds of dried salt to a ton of air dried pulp kept it practically clean for a year. A 3 per cent solution permitted only a slight molding. Among the other compounds tried were borax, boracic acid, sodium dinitrophenolate, sodium bichromate, sodium carbonate and bicarbonate.

Coloring Gems

AT the Reno Station of the Bureau of Mines where special attention is given to rare and precious metals it has been found that colorless gem stones may be temporarily colored through exposure to radium emanation. A colorless Colorado topaz was tinted yellow by such exposure though this color was not permanent when afterward exposed to light. It is too early to predict what the outcome of this discovery may be and further work has been undertaken looking toward making such coloration permanent. Should this prove successful it would be possible greatly to increase the commercial value of many of the gem stones now found in the West but at present considered of low value because of the lack of color.

Reports of the Progress of Applied Chemistry

THIS is a volume issued by The Society of Chemical Industry, and Vol. 5 for 1920 is just now available. It is an interesting collection of twenty-five reports, each by one or more specialists who have reviewed the progress of applied chemistry in their own special field for the year 1920. It is to be recommended to all those even remotely interested in the subject, for the reports are not too technical to be read with interest by the non-technical reader.

In the chapter on gas, destructive distillation, and tar products, we find that H. E. Wright considers that coke oven regenerating settings give 6000 cubic feet of surplus gas per ton of coal as surplus. For town supply this surplus coke oven gas is considered superior, from the economic standpoint, to the gas supplied by the present gas works system. The chief trouble anticipated in the use of surplus gas is in the supply of constant quality. For this reason double mains are advocated for separating the rich and poor gas, as the former only would be used for domestic purposes. In most localities little effort has so far been made to use such surplus gas.

Another author in commenting upon the advantages which would accrue from the use of cheap oxygen in metallurgical operations suggests that perhaps the solution for the problem of storing hydroelectric energy lies not in the perfection of lighter weight and cheaper storage batteries than we now have, but in the use of the current for the production of hydrogen and oxygen. These gases could be stored without difficulty and used in established processes as well as many others which would certainly be developed if there were large quantities of such gases available at a low price.

Those who have seen the experiment of breaking a a wine glass by striking the proper note on a violin will be interested in a method patented by H. Püning for removing dust from the settling surfaces employed in electrostatic precipitation. The method consists in the use of a whistle or siren by which sound waves of sufficient intensity to cause dislodgment are set up. There have been other examples of the force of such sound waves as, for example, in range finders where it has been necessary to place diaphragms so that sound waves set up by the firing of the guns might be so broken as to prevent their causing the breakage of taut piano wires upon which the optical systems are mounted within the protecting metal tube.

It is not surprising to find little reference to research in America on matters pertaining to fabrics, for, as is well known, our textile industry is one of those which thus far have not been convinced of the advantages to be gained through the application of science to the industry. In Germany, a prize of twenty thousand marks has been offered for a method of ascertaining the end point in the retting of bast fibers and further prizes for a method of avoiding the objectionable odor and injurious nature of the effluent from the retting processes. Still other prizes are offered for a practical method of artificially drying retted flax and hemp.

Agricultural Insecticides

R. R. HENDERSON in the June *Chemical Age* (New York) discusses raw materials and methods of manufacture of the principal agricultural insecticides. Insecticides and fungicides have been increasing of recent years and by the application of colloidal chemistry and other advanced sciences many improvements have been made. Arsenic acid is perhaps the principal ingredient in insecticides. Some years ago certain smelters stated that when arsenic would be worth two cents a pound they could afford to save it but not otherwise. Last year it sold as high as seventeen cents a pound although at present the price is about one-third that figure. Its principal sources are the United States, Canada, and Japan.

Lead and lime are other important base materials and sulfur is used as such as well as in certain combinations. Tobacco in the form of scraps, stems and sweepings are used after a reduction to fine powder for dusting and as raw materials in the preparation of nicotine solutions and nicotine sulfate. A number of oils find application as emulsions for plant lice and scale insects. Petroleum and fish oils are the ones principally used. Lime sulfur solution was developed originally for dipping sheep and its usefulness as a spray was discovered when a farmer decided to try his sheep bath mixture on a badly damaged orchard. In an effort to reduce the expense and difficulty of handling liquid lime sulfur, research was conducted a few years ago to see whether dry lime sulfur might not be prepared. A certain measure of success was obtained, it having been found that if some such material as starch or sugar were first mixed in small percentage with the lime-sulfur solution the mixture could be dried in vacuum. It is interesting to know that the manufacturer who supported the original research has not made use of the results although certain of his competitors have done so. The dry product is not as stable as could be desired and has a tendency to decompose on exposure to air with an increasing percentage becoming insoluble with age.

London purple which was extensively used a number of years ago was originally a by-product of the dye industry and consisted principally of arsenite and arsenate of lime. When the arsenic process for the manufacture of magenta was replaced by the nitro-benzene and synthetic formaldehyde process there were no arsenic by-products for sale. The small amount of London purple now used is specially prepared from waste materials containing arsenic. Even paris green has been largely superseded by arsenates of lead or calcium. Paris green is an aceto-arsenite of copper prepared from copper sulfate, acetic acid, carbonate of soda and white arsenic.

The use of oil emulsions has always been interesting and has involved considerable research in the preparation of certain emulsions. The following is quoted from the article in question:

"These may be prepared in several ways. Soap is dissolved in water and the solution heated. Petroleum oil is then run in and the batch thoroughly mixed and pumped under high pressure through fine spray nozzles. The passage through the spray nozzle causes the formation of a white creamy emulsion.

"Another method is first to mix the petroleum with some form of saponifiable oil as fish oil. A caustic soda solution is then run into the batch, while it is rapidly agitated, in sufficient amount to saponify the fish oil. This also forms a white creamy emulsion.

"Emulsions also may be prepared by mixing sulphonated oils with petroleum. This forms a miscible oil which, on later dilution with water, will form an emulsion.

"Not all petroleum distillates are toxic to insects. In just what portion of the crude petroleum the toxic principle lies has not been investigated thoroughly. Vickery, in the *Journal of Economic Entomology*, states that 'kerosene, particularly in California, sometimes fails unaccountably to kill scale insects.'

"The reason for using the oils in the form of an emulsion is that this renders dilution possible. If the concentrated raw oil were used on plants it would injure them. Recently oil emulsions have been prepared by using certain colloidal materials as emulsifiers. These materials assisted by agitation cause the oil to break up into very fine particles in the watery mixture and finally form a very stable emulsion."

Production of Pure Hydrogen

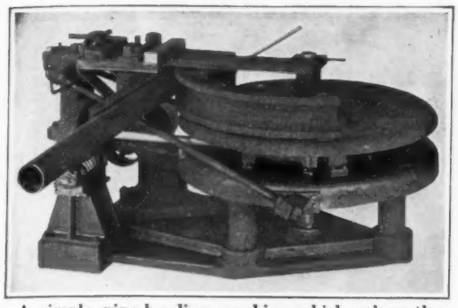
IN *Comptes Rendus* for April 18, Claude discusses his experiments on the production of hydrogen of sufficient purity and low cost to guarantee the commercial success of his hyper pressure process for the fixation of atmospheric nitrogen in the form of ammonia. Water gas and coal gas must be separated as well as carbon monoxide which is both objectionable and has heretofore been difficult to eliminate completely. Claude makes his separation by applying the principle of the insolubility of hydrogen and the solubility of other gases of the mixture in ether. The mixture is compressed to a given pressure and passed through the solvent at a low temperature. All gases but the hydrogen are dissolved. The solvent is drawn off and when expanding to atmospheric pressure the gases escape, leaving the solvent ready for reuse. After a series of researches it has been found that carbon monoxide can be reduced to a minimum by working at a temperature of 40 degrees below zero and a pressure of about 100 atmospheres. By this method the hydrogen contains less than 0.002 parts of carbon monoxide.

Synthetic Insulation Materials

R. W. KENNEDY in the *Electrical Review* reports tests by the National Physical Laboratory on synthetic insulation materials showing the exceedingly good insulating properties of artificial silks particularly those based on cellulose acetate. These silks have been found superior to ordinary real silk insulation. Coils of iron covered with these materials gave results much in favor of artificial silk under the various conditions of temperature and humidity, especially when such insulation had been given a dip in a solution of cellulose acetate in acetone and chloroform. Such a lacquer of non-inflammable cellulose compound in a volatile solvent has been found satisfactory as an insulating varnish and when formed in sheets as suitable for accumulator cases and for general insulation.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts



A simple pipe-bending machine which solves the pipe-bending problems of the small and large shops alike

Facilitating the Bending of Iron Pipe or Tubing

AMONG the latest labor-saving devices is the pipe bender shown in the accompanying illustration, which is designed for bending standard iron pipe or tubing up to 4-inch pipe size.

The roller bracket of this machine is adjustable to take forms up to 48 inches in diameter and is operated with eccentric lever to force the tube or pipe into a groove or form for holding the outside follower bar close to the tube. This is absolutely necessary to secure the best possible results. The machine is operated by lever engaging friction clutch pulleys for forward and reverse drive. Adjustable stops are provided to suit any degree of bend required. Clutch is automatically thrown out of engagement at both the end of the bending operation and when the machine has been reversed to the starting position.

Special forms with inside follower bars or floating mandrels can be furnished for bending light gage tubing to a short radius without flattening or crimping, so it is claimed. The pipe is secured to the form by means of strap and eccentric lever and both the inside follower and the form are grooved with the proper thickness to secure the best possible results.

Motor-Driven Hair Cutter

A GERMAN barber has invented a simple motor-driven hair cutter, which is shown in the accompanying illustration. The 110-volt electric motor drives the hair cutter mechanism through a reduction gearing, and the barber's hand is not fatigued as in the usual hand-operated hair cutters. And it is well to bear in mind that in Germany and other European countries a hair cut is a pretty thorough job, with every hair cut down to almost nothing, as compared with our extravagant and frequent American trims.

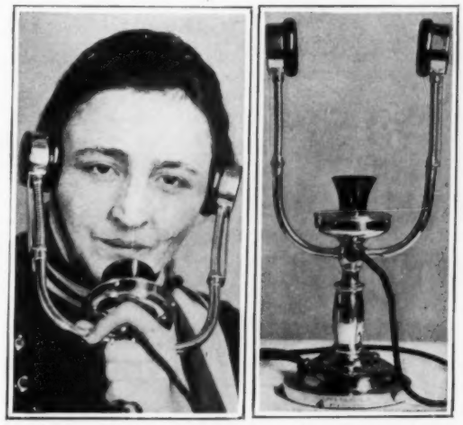
Electrically-operated hair cutter which enables this German barber to save much time and effort

A Face-Grinding Table for the Disk Grinding Machine

TO fill the need for a powerful disk-grinding machine which incorporates a hand-feed work table of the face-grinding type, a Wisconsin manufacturer has developed this device. The table is particularly useful in grinding large work where heavy cuts are required and also on longer parts such as exhaust manifolds, lawn mower bars, machinist's levels, and so on.

The sub-slide is adjusted on ways to the position desired and is locked with jib screws. A worm and nut actuates the cross feed slide and the micrometer markings are found on the hand wheel. A rack and pinion operates the longitudinal travel of the table top. Adjustment is provided so that there is sufficient clearance at the rear side of the grinding wheel.

The center of the work to be ground is brought up to the center of the grinding wheel as the fixtures are built at the proper height for this. It is claimed that this type of table lends itself especially to the use of rotating and revolving fixtures.



Telephone instrument invented by an American woman, for the purpose of increasing telephone efficiency

Something New in Telephones

DESPITE the fact that we have come to consider the desk type of telephone instrument as a standard, it seems that there is room for improvement. At any rate, inventors from time to time turn their attentions in the direction of evolving better and more convenient types of telephone instruments with interesting results.

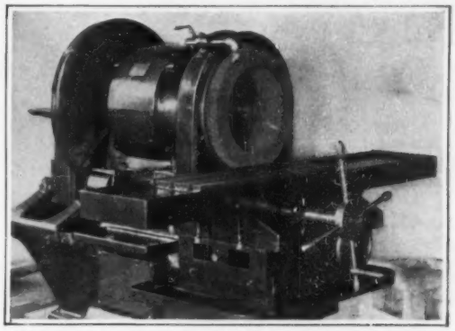
Now it is Miss Katherine Nichols, of New York City, who has invented a new type of telephone instrument. Her invention is known as the combination type. As shown in one of the accompanying illustrations, it has a double receiver device which excludes all outside noises. It can be picked up and talked into as with the ordinary desk telephone, and the double receiver feature is claimed to increase its efficiency by fully 50 per cent. In fact, if anything, this radical departure from American practice is strongly suggestive of European practice, where transmitter and receiver are mounted on one arm so as to be handled together.

Reducing the Ammeter to Its Simplest Form

THE ammeter, shown in the accompanying illustration, has been designed primarily to test dry cells and affords the only means of indicating the condition of the cell. It is constructed so that contact may be made directly to the battery without the use of a wire lead, but a terminal is provided so that a lead can be used if so desired.

A dry cell may be tested with this new ammeter by placing the metal insertions on the back of the instrument, to the terminals of the cell. Each small division on the dial represents two amperes. A dry cell of ordinary commercial size when new should register approximately 28 amperes.

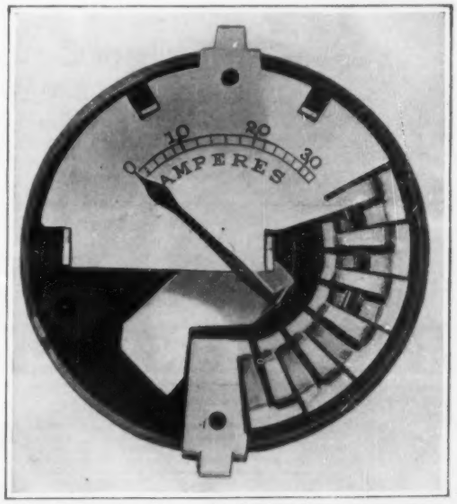
A one-piece aluminum punching serves as the coil or solenoid, as well as the terminals, dial plates, the mounting for the armature and the support for the glass. The entire collection thus formed is placed in a rubber composition case, so as to form an ammeter of the most simple design and construction. This unique construction, it is claimed, eliminates soldering the screw connections common in other meters, making a more durable, dependable and accurate instrument. The meter is sealed so that it cannot be opened or tampered with, and should give long and satisfactory service. The stamped coil or solenoid is the feature of this invention and may be made adaptable to other electrical devices such as relays, circuit breakers, indicating instruments, transformers, or other appliances that require the use of solenoids and armatures.



The hand-feed work table brings the work up to the face of the grinding wheel and regulates the grinding action

Uses of Metallic Magnesium

THE addition of half of one per cent of magnesium to castings of copper, brass and aluminum, adds greatly to their strength, according to a writer in the *Teknisk Ukeblad*. When magnesium is exposed to high pressure steam the surface is oxidized and this oxide can only be removed by heavy hammering. The oxide is one of the best insulating materials in existence, as a layer 1 mm. thick, which may be deposited in 15 minutes by exposure to steam of 20 atmospheres, will resist a pressure of 20,000 volts. Electrical insulators for high-pressure transmission lines requiring great strength and high resistance can therefore be made of this metal or its alloys. Magnesium plates treated in this manner have also been found excellent for electric cookers, heaters and radiators as the radiating power amounts to 75 per cent of the total heat compared with only 25 to 34 per cent from ordinary metal surfaces. The balance of heat in the latter instance being emitted by convection, is not economical on account of the direction it follows, viz., vertical.



Working parts of a newly designed ammeter. One stamping serves as the solenoid and other parts

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Rapid-Transit Arithmetic

(*Continued from page 185*)

London transit lines was wrought by the increased fares, as shown by the following condensation of Lord Ashfield's report:

During the first three months of 1920 the underground carried 108,000,000 passengers, receiving an average per passenger of 2.5 pence (five cents). During the last three months of the year, 98,000,000 passengers for an average of 3 pence (six cents).

In the first three months, the omnibuses carried 217,000,000 passengers for an average fare of 1.75 pence (three and one-half cents). In the last three months, 199,000,000 passengers for an average of 2.5 pence (five cents).

In the first three months the trams carried 51,000,000 passengers for an average of 1.5 pence (three cents). In the last three months, 47,000,000 passengers for an average of two pence (four cents).

It worked out that, although on the total year's traffic there was an increase of 110,000,000 passengers, the traffic in the last three months was less by 32,000,000 than in the first three months. A two per cent decrease in these three months as related to the year's total haulage, plus the fare increase, lifted the companies from necessary Government aid to financial independence. The people were bound to pay the extra charges in any event, whether indirectly in the form of Government subsidy, or directly in the form of increased fares. It was not arbitrary action, nor was it corporate manipulation which wrought to produce those increased fares in London. It was the Median and Persian law of economics—the law of the economic unit—which compelled that result.

It is not suggested herein that this purports to be an exhaustion of this subject, or even to be a complete syllabus. It is merely to descant on the scientific phases of the interesting situation of transit in London, it being true that principles fundamental there must be and are fundamental everywhere, principles being universal.

The point of scientific interest in these figures and facts is that there is a general misapprehension by the popular mind of the science of the economic unit—a misapprehension not at all surprising. Not only the "mass" of the people, but hosts of otherwise well educated men and women, labor under the delusion that the larger the city the smaller the construction and operation costs per unit of public utilities.

This delusion was cited to me by the late Mr. Theodore N. Vail, President of the American Telephone and Telegraph Company, one day, in his offices in New York headquarters. Going to a window, and pointing downward to workmen engaged in tearing up a street and laboring among the net work of utility accessories, he said:

"You are right in applying the principle of the economic unit to this problem. It is difficult to explain to the people why the cost of installing and maintaining a telephone increases as the city grows beyond a given economic size. Just what that economic size is, we cannot precisely define. But it is obvious that New York City with its six millions of population has passed it. Every movement by workmen is hindered by the presence in the street of the other utility works. Every act costs more for that reason. Yes, it is the principle of the economic unit that explains it—but it is hard to make the people understand it."

The President of the Society of Mechanical Engineers of Great Britain, delivering his annual address before that body early this year, declared that the cost per passenger-mile on the London 'buses was more than one hundred per cent higher than the cost per passenger-mile on the underground. Although he did not minutely analyze the statement,

(*Continued on page 192*)

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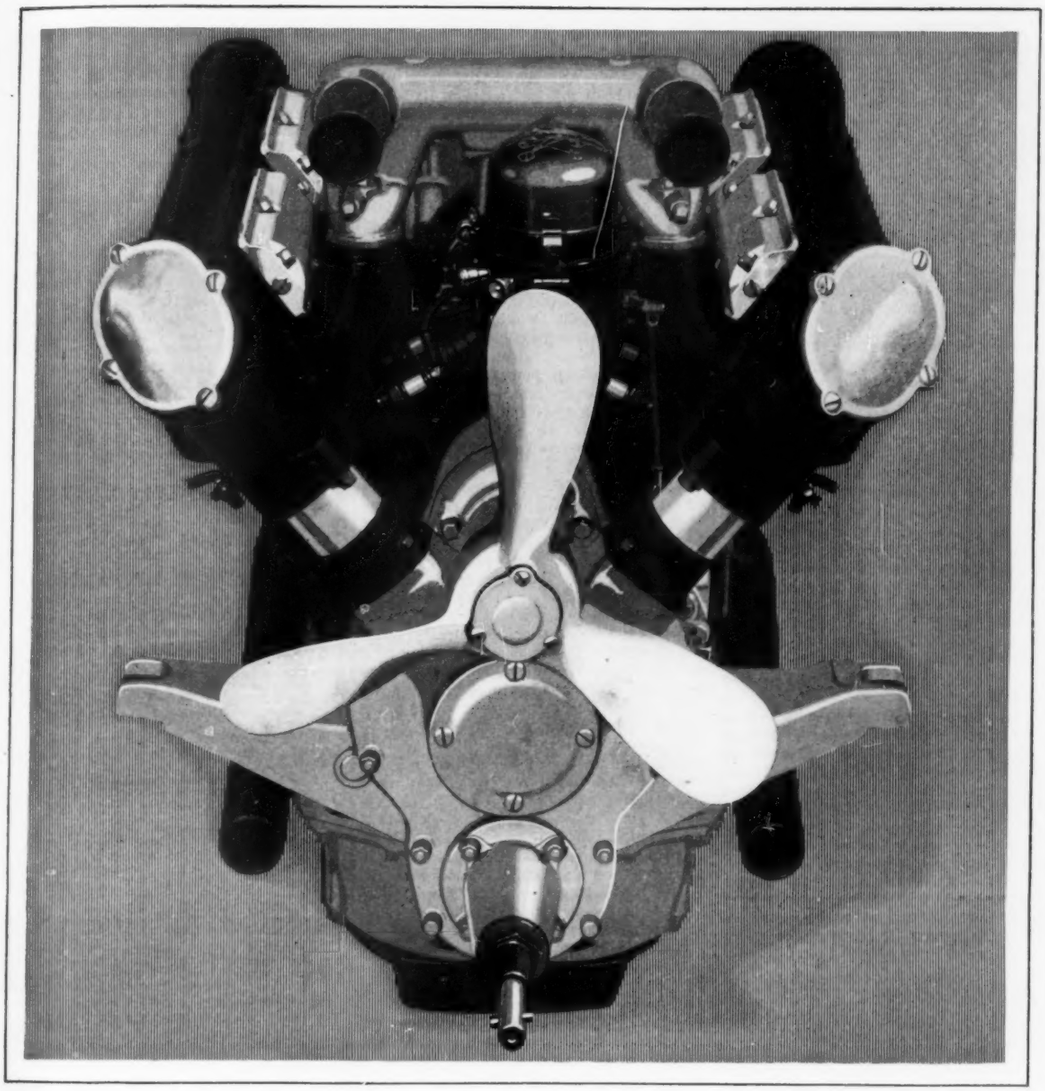
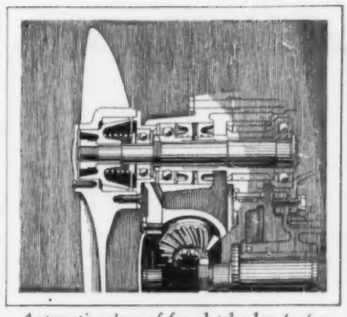
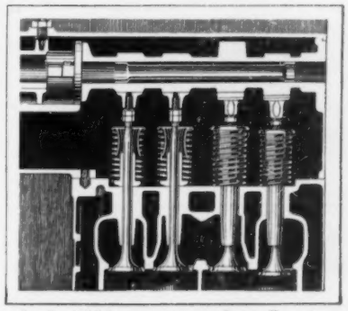
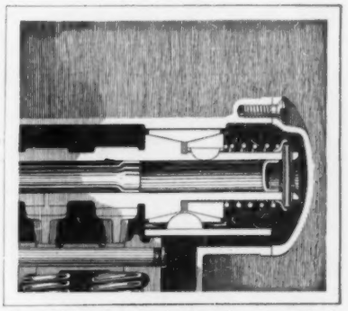




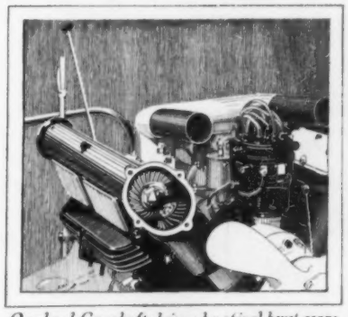
Automatic release of fan clutch when proper cooling speed is reached effects large saving in horsepower



Overhead Valves seat accurately at all temperatures because of scientific skill used in selection of materials



A simple steadying or braking device on end of crankshaft eliminates usual noise



Overhead Camshaft driven by spiral bevel gears and pinion—No chains are used

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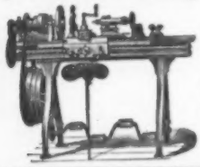

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Rapid-Transit Arithmetic

(Continued from page 190)

it was obvious from the context that it was the intense involvement of the street traffic—the maze of buses, trams, automobiles, horse-drawn vehicles and pedestrians in a congested state which entailed the added per-passenger-mile charges for operation.

I submit that until these scientific truths be elucidated to the people there will be no intelligent public consideration of public utilities. So long as there be unenforced comment, there will be unfortunate prejudice. And so long as unscientific ideas prevail among the people, the politician with public-favor axes to grind will befog the issue.

If, however, anyone will take the trouble to find the true answer in his own experiences as he moves about in a crowded, congested city, he will easily understand this apparently obscure meaning of the principle of the economic unit.

His delay at street corners when traffic is flowing past; his extra time required to get from his office to call at another office, the constant toll of time which he must pay in going from point to point.

If he, then also the public utility workman, must pay that toll of time; if he, then the public utility itself, must constantly pay the super-charge of time and money in doing business in a very large city; and if so, then charges must advance—as a general proposition, and under existing forms of mechanical procedure.

No one may foretell what will be true in the distant future. It may be that ingenuity will devise methods of overcoming the resistance of intense large-city involvement. But that it has not yet been done must be conceded by all who can see the fact when presented, and apply to the utility the principles which he himself applies, perforce, every day he lives in and does business in one of the world's metropolises.

From Star to Chronometer via Radio

(Continued from page 186)

Cavite (P. I.), North Head (Wash.), Eureka (Cal.), Point Arguello (Cal.), San Diego, San Francisco, Great Lakes (Ill.), and Pearl Harbor (T. H.). Some of these stations send spark, some are signals, and four send both. Where two or more stations can be heard simultaneously a large variation in wave length is arranged; thus, Washington sends 2500 meters and Annapolis 1700 meters; Balboa 7000 meters are and Colon 1500 meters spark.

The accuracy of the time signals as sent and received by radio is of course of extreme importance. Determinations of this accuracy are carried out constantly. Any navigator assumes, on receiving a radio time signal, that he is getting true time, or time which varies from the true time by an amount of which he has been previously warned. Washington signals lag behind true time nine hundredths of a second; the lag in Annapolis time is 0.07 second. These are known errors, which are practically constant. They are caused mechanically by the relays which are in the land line circuits. It is true time which starts from the Observatory transmitting clock, but a relay starts the signal over the wires and another receives it and turns it into the automatic machinery which sends out the radio signal. In these relays there is the slight loss of time noted. In the Key West signals there is a lag of twenty-eight one-hundredths of a second, due to the larger number of relays between Washington and Key West.

The lag, however, which is always a *plus* error . . . that is, the signal was late in starting and so we must have added to it the amount of the lag to get the true time . . . is not the only error. Other causes result in small errors (generally less than a tenth of a second) which are of no real importance to navigators, but which may be of great importance to those who are using time signals for accurate surveying or longitude determinations. A careful check is made of these errors, which are listed by days and amount plus or minus, and such lists are sent out monthly to all who request them, and regularly to such organizations as the Coast Survey, the Bureau of Standards, several watch companies, the Bureau of Railroad Time Service, etc.

The development of radio time signals to be sent out from the United States has reached its maximum as regards the number of sending stations—it is even possible that one or two might be omitted without material injury to the service. There is no need to add other stations within the radius in which existing stations can be heard. But the radio time service is making constant strides forward in accuracy and in research. At present, experiments are being conducted with a view to the elimination of long land lines, such as from Washington to Key West, and sending Key West a radio signal which will there be picked up and automatically be sent out from the Key West Radio Station. Such an accomplishment will reduce the present large lag to a very small one.

Another development of great interest is the comparison of the radio time signal with the apparatus which sends it. At the Naval Observatory electrical apparatus has been installed which permits a received radio signal to operate a chronograph. This results in the most accurate determination of error in a time signal. Thus, Washington sends out a time signal, over the wire; it is received at Great Lakes and sent out there by radio; Washington receives the radio time signal, and puts it on the chronograph side by side with the record of the same signal as it was sent. The comparison is exact, and the error can be analyzed and the proper values assigned to lag in relay, and error in signal. Signals have been sent to Australia in connection with longitude determinations, and for such a distance the time required for the transmission of the radio wave must be taken into account. Radio travels at the speed of light, roughly 186,000 miles a second. Australia, half way round the world is roughly 12,000 miles away. The signal, then, requires about 1/15 of a second plus, to travel the distance.

The reader with an imagination is asked to recall the fact that the astronomer at Washington is at one point upon a ball which revolves once in twenty-four hours. The ball itself travels about the sun once in a year through a path which is some six hundred million miles in length. The sun and all its train of satellites, of which the earth is one, is moving through space toward an unknown destination. Yet in spite of these complicated movements, at tremendous speeds, the astronomer reaches a star with an arm of light, determined an instant of time for a single place and calls it noon, and then, with an arm of unseen radio wave in an unknown medium he calls the ether, sends that instant broadcast to all the world, for all the world to pick up and use and depend upon for everything it does, from going to breakfast to going to war, or deciding the boundary between states or the exact and accurate location of those who go down to the sea in ships.

Using Cadmium to Galvanize Iron

WHILE it has long been known that so-called galvanized iron could be made with cadmium in place of zinc, its high price prevented such use. A writer named Grès states in the *Bulletin des Inventions* that this difficulty has been overcome since it has been found possible to galvanize 1 square meter of sheet iron with the use of only 34 grams of cadmium. The coating thus produced is more resistant than zinc to acids, salt water and damp air. In spite of its thinness it clings to the iron with great tenacity, not cracking even when the latter is bent.

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